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THE PURPOSE OF A UNIVERSITY

THE proceedings of the Congress of Universities of the Commonwealth which was held in Cambridge last week were divided into a number of sessions on specific topics. Nevertheless, permeating the whole, there was the thought of the purpose of university education. Some recent pronouncements on this topic are thus of immediate interest.

At the recent jubilee thanksgiving service of the University of Liverpool, the Archbishop of York, Dr. Cyril Garbett, urged that the noblest task of a university is to encourage in its students the disinterested and relentless search for truth. First and foremost, he said, a university exists for knowledge, and while earnestness in the search for truth is characteristic of what is best in the younger generation, those responsible for the work of a university should manifest a fearless and disinterested love of truth in all its departments. This is the most effective safeguard against the attack upon freedom.

The existence of a sufficient number of men and women who have been taught from their student days to value truth and to question and to criticize unproved assertions is the best defence against this danger, as has been shown in the United States when the academic freedom of the universities was threatened by security proceedings. That may well be the most important social function of the universities at the present time, and it may have determined Dr. J. B. Conant's choice of the title "Education and Liberty" for his recent book on the role of the schools in a modern democracy. Dr. Conant took as his text the words Thomas Jefferson wrote to Washington in 1783: "It is an axiom in my mind that our liberty can never be safe but in the hands of the people themselves, and that, too, of the people with a degree of instruction"; and he discusses principally the changes in education at the school-level which are necessary in the United States to ensure the safety of freedom. Nevertheless, his theme is more related to that of the purpose of a university than would immediately be apparent to those unfamiliar with the overlap of the American college system with secondary education and university education in Great Britain.

Dr. Conant's book is appropriately recalled here because, although he says little directly about the search for truth or the defence of freedom, he is concerned above all with making men and women competent to play their full part in the world to-day. This, said Dr. Garbett, is the second function of the university; and here, too, in the development of personality in its students, in encouraging the exercise of responsibility and initiative, which, if a democracy is to endure, must be possessed and used by the many and not by the few, the university exercises a social function. Sir John Stopford, speaking later on the same day, emphasized the civic as well as the national and regional functions of the universities; and in referring recently to the work of the University Appointments Board at Manchester, suggested that the actual placing of graduates might well be less valuable than advisory work, in which the Board helped them to choose the appropriate discipline.

That point was elaborated further by Sir Hector Hetherington, vice-chancellor of the University of Glasgow, in his Essex Hall Lecture, "The Social Function of the University", recently published*. It was also put, but somewhat differently, by Lord Beveridge in writing on the main purpose of university life, as learning to use freedom. The extent to which a university succeeds in this largely determines that to which its graduates will succeed in taking their proper place in industry and in the public services, as well as in scholarship and the learned professions, and in breaking down inhibitions against their employment.

Sir Hector Hetherington lays his main stress on education as the prime social function of a university. He recognizes, too, that there is also the communication of a culture and the discovery of new knowledge or research. Of the last, he observes that because real research or real scholarship is hard and punishing work, there is danger that the balance of interest of the ablest people may tilt too heavily in that direction. A university cannot be built if too many of its leading people come to regard teaching as second best. Also, the difference between research in the arts and in the sciences has been responsible for a change in the climate of opinion, and art disciplines, he thought, in changing their direction have moved onesidedly and a little lost their way. Also, while research is a superb and fortifying discipline, there is a tendency, he said, for it to be undertaken, both in the arts as well as in the sciences, before the student has obtained the indispensable comprehensive grasp of the material of his subject.

Sir Hector Hetherington's conception of the university's function of education is not narrow. It embraces the content as well as the communication of knowledge, the ways and habit of winning knowledge, and the judgments to be made in its assessment and use. To this he devotes the major part of his lecture, and it will be noted that, by and large, he confirms here much of what was said by Sir Richard Southwell in his Trueman Wood Lecture before the Royal Society of Arts on May 13. Sir Richard Southwell was dealing specifically with training in science and technology, and insisted that the structure of technological education in any country is, and should be, conditioned by the structure of its industry, and that this in turn is conditioned by its history. For this reason he was averse to rapid change, quoting Bacon's warning that "it were good . . . that men in their innovations would follow the example of Time itself". Sir Richard was opposed both to the lengthening of university courses and to the proposal to build a technological university on the lines of the Delft or Zurich Technical Colleges or the Massachusetts Institute of Technology. He did not deny the need for training to a high level in the specialized technologies of industry, but he insisted that the study of the application of science should take place where its development occurs—the vicinity of works or of great research institutions; application cannot be presented *in vacuo*.

* The Social Function of the University. By Sir Hector Hetherington. (Essex Hall Lecture, 1953.) Pp. 29. (London: Lindsey Press, 1953.) 2*s*. net.

Sir Richard was anxious to safeguard the undergraduate against demands which threaten his wider education, and he visualized the universities as concerned primarily with the science which is pursued with the view of application, not directly with applications. At the undergraduate-level, the teaching should endeavour to instil a knowledge of the basic principles and the power to grasp essentials of a problem. At the postgraduate-level, however, the university should not only continue to supervise research but should also provide courses in the newer and harder parts of applicable science, and here he stressed the need for close contact and co-operation between the universities and the monotechnics and industry.

Sir Hector Hetherington reaches similar views from rather a different angle. He seeks first to find the criteria which should determine the contribution of the university to the making of a professional man. Professional competence, he points out, calls for more than can be provided by any university; equally, the highest level of professional service calls for more than technical skill. Accordingly, the university's first contribution is to teach the professional man what he needs to know, and to teach him systematically, organically and thoroughly, so that he is master of it, and can use it to guide his actions in ways yet unforeseen.

As the basis of intelligent participation in the affairs of his society, however, the professional man needs also to see his specialisms in their relationship to one another, as mutually sustaining elements in a living system, the place and claim of which in the larger context of human experience and reflexion he must to some extent understand. Thus, like Sir Richard Southwell, Sir Hector claims that the aim of university teaching should be to provide for all kinds of students, not a professional training but an education for professional service, a discipline which fits a man not only to meet the technical demands of his vocation, but also to share the concerns of a civilized society, to accept the enjoyments, the privileges and the responsibilities of the continuing life of his community.

To meet this demand for wisdom as well as power, Sir Hector suggests first that the universities and their teaching staffs should take quite seriously the precept that their business is education and not training. Accordingly, the universities should accept as falling within their province only those professions the basic disciplinary requirements of which are capable of being the instruments of a genuinely educational process, of recognizable breadth and depth. They should admit all which meet this criterion, but no others. Like Sir Richard Southwell, he holds that if no more is wanted than techniques, it is not a matter for the university, although if genuine and systematic learning is involved, the university should, in principle, be ready to be concerned.

Sir Hector Hetherington does not think that British universities have been at fault in this regard, nor does he think there is general disagreement with his second principle, that universities should accept only those students whose attainments give some

assurance of their ability to sustain the discipline of a university education. Controversy has arisen rather over the application of this principle, and he pointed out that university requirements must be conceived not only in terms of what the universities think to be necessary, but also in terms of their effect upon the general working of the schools. Further, the duty lies upon the university system as a whole of seeking to provide places for all who are fit and who desire to enter, though not necessarily the places which the candidates profess a desire to occupy: the universities must try to keep their services in some kind of balance with effective demand.

The third point made by Sir Hector relates to the formulation of university curricula. The primary requirement is that sovereign place at the university should be given to the educational rather than to the professional end. The professional intention prescribes the disciplines through which the educational end is to be achieved; but achievement is only possible if the content of every element in the programme and the mode of its presentation are weighed by an educational rather than by a professional measure. Sir Hector recognizes that this calls for a liberalizing, and a lightening of specialist courses, at the very moment when the growing complexity of professional services invites the further elaboration of specialist courses. None the less, it is inescapable if we accept the proposition that the university's primary objective is an educated man rather than an expert trained to the highest point of the moment's need.

Sir Hector pointed to some of the implications for the social life of the university, particularly the design and building of its organic life so as to provide for more abundant contact between student and staff in small groups and for the vital contact of minds; and in the ordering of courses and the scrutiny of the educational value of subjects admitted to a university curriculum, so that the university might realize its creative power to the full. While he said little on the university's function in the communication of culture, he said enough to bring to light the central issues as clearly as Sir Walter Moberly has done. A university is above all dedicated to the pursuit of truth, and there is no other way to truth than by untrammelled thinking, by following the argument wherever it may lead and by meeting the critical encounter of judgments other than one's own. Nor can an institution long endure if it has at its heart no more than a bundle of negations; and in his review of the social functions of the university, Sir Hector finds grounds for confidence for the future of the university and the society in which it exists, precisely because the conditions attached to its freedom of inquiry and teaching—responsibility and competence—have such a positive and constructive role in the society of to-day. Upon their exercise, as Dr. Garbett pointed out, the future of democracy largely depends; and Sir Hector concluded his lecture on a confident note that by patience and humility the universities would discharge their responsibility and provide society not merely with leadership but also with wisdom and vision.

THE ESSENTIAL OILS INDUSTRY

The Essential Oils

By Dr. Ernest Guenther. Vol. 5; pp. xvii+507; 70*s*. net. Vol. 6; pp. xvi+481; 73*s*. 6*d*. net. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1952.)

IT seems a happy necessity that has finally extended the number of Dr. Ernest Guenther's volumes to six. In this respect, as in its total of well over a million words, the work now matches Gibbon's "Decline and Fall"; and in well-ordered presentment of the fruits of enormous study, it is not unqualified to sustain the comparison. Fittingly, therefore, recalling Gibbon's memorable introspection on the completion of his task, one may congratulate Dr. Guenther on the recovery of his freedom, sympathize with his sober melancholy in taking leave of an old and agreeable companion, and assure him as to the establishment of his fame.

Admittedly, the scientist's achievement is less spectacularly single-handed than the historian's. As noted in the reviews of the earlier volumes[1] and exemplified in Dr. Leo Goldblatt's monograph on the American turpentine industry in Vol. 6, Dr. Guenther has made way for able specialists in particular sections, constituting perhaps one-tenth of the whole. Nor can the scientific world be unmindful of a great debt to the firm of Fritzsche Brothers, without whose unstinted support the publication could evidently not have been a practical possibility. Yet Gibbon's monomachy was a triumph exclusively of the library, while Dr. Guenther has refought his battles on the very ground, in the pleasant fields of Grasse and in regions much more remote: a valuable instance is his first-hand study, in Vol. 5, of the complex fractionation and grading of ylang-ylang oil as practised in the Madagascar islet of Nossi-Bé. Before relinquishing the comparison, let it be said that Dr. Guenther's prose, while rightly refraining from the Roman majesty, is noticeably free from those infelicities to which the merely industrious compiler is so commonly prone.

The two present volumes, continuing from Vols. 3 and 4 their account of individual essential oils, deal chiefly with the products of those plant families which, though low in the scale of quantitative output, gain importance from their commercial history and from their special characters as perfumes and flavours. Here, therefore, are most of the examples of the preparation of concretes and resinoids by non-distillation methods: processes as old as Homer, such as the extraction of rose oil into fatty pomades, or as recent as the extraction with such newer solvents as butane, by which the hitherto unattainable concrete of lily of the valley is now being prepared.

Though the pure chemistry of the constituents of essential oils was formally dealt with in Vol. 2, Dr. Guenther has profited by his opportunity of recording subsequent advances in this field. To quote only a few examples from the present volumes, the monograph on *Thuja plicata* discusses the naturally occurring *cyclo*heptanone derivatives (tropolones) down to the synthesis of the three isomeric thujaplicins in 1951. The account of oil of hops includes a survey of recent investigations on the structure of α-caryophyllene and its identity with humulene. Among other compounds for which these volumes record structural formulæ proposed, revised or confirmed since the publication of Vol. 2 are cedrene, lanceol, β-santalol,

zingiberene, kessyl alcohol, luparol and the polyacetylenic compounds of the "matricaria-ester" type. Noteworthy also are the first records of the natural occurrence of a sulphoxide (sulphoraphene, in oil of radish), the tricyclic terpene tricyclene in hemlock-spruce oil, and piperettine, a homologue of piperine, in oleoresin of pepper.

Analytical procedures described in Vol. 1 have also been amended where necessary in view of later work: for example, the thiosulphate factor in ascaridole determination. One might wish, perhaps, for fuller documentation of the statement that the halogen test (for synthetic benzaldehyde as opposed to natural oil of bitter almonds) has lost much of its importance owing to the production of the synthetic material in a higher state of purity. It is not clear whether this opinion takes account of very delicate chlorine determinations by the lamp method[2], to which the book does not explicitly refer.

Consideration of the six volumes as a whole may well prompt the reflexion that the essential oil industry has been singularly blessed in the production of such a book at such a juncture as the present. Even a few years ago, it would have been impossible to include much of the material descriptive of new and rationalized production techniques, which may be considered as prefiguring the industry's future; while in even a few years more, oblivion perhaps may begin to overtake much of its historic and romantic past—the buccaneers and galleons, and such strange contrasts as that between the sandalwood of Mysore, owned and accounted for to the last stick by a solicitous government, and the copaiba of Brazil, produced obscurely out of Amazon jungles by native woodsmen calling no man master. To students of either past or future, the book must be equally invaluable.

In view of the progressive additions of new work, to which reference has already been made, a comprehensive index is a necessity for making the fullest use of the book. This is provided in the sixth volume, and extensive trials of its adequacy indicate it as an ending which may be said to crown even a *maximum opus*.

E. G. Kellett

[1] *Nature*, **163**, 663 (1949); **164**, 895 (1949); **166**, 753 (1950); **168**, 395 (1951).
[2] For example, *Analyst*, **60**, 29 (1935).

SCIENTIFIC THOUGHT THROUGH THE MIDDLE AGES

Augustine to Galileo

The History of Science A.D. 400–1650. By A. C. Crombie. Pp. xv+436+12 plates. (London: Falcon Educational Books, 1952.) 42*s*. net.

"We have now to consider more especially a long and barren period, which intervened between the scientific activity of ancient Greece, and that of modern Europe; and which we may therefore call the Stationary Period of Science. . . ." The quotation from the "Dunciad" which precedes the above passage indicates the probable source of William Whewell's judgment on the science of the Middle Ages. The almost universal self-complacency of the eighteenth century was expressed with such linguistic facility as to create a mist between later scholars and medieval ideas, which despite the wind of criticism of Duhem, Haskins and many others has been slow to clear. Indeed, even in the recent literature of Great Britain it would not be difficult to find judgments differing little from that of Whewell. Dr. A. C. Crombie's book is therefore doubly welcome; for, providing as it does the first reasonably complete survey of the period within a moderate compass, it will be an invaluable work of reference for the medieval historian and a richly rewarding study for those men of science for whom last year's books are not already out of date.

The plan of the book is based on the sound assumption that to do justice to the history of an epoch we must first make sure that we understand the nature of the questions to which answers were then being sought; for only by so doing can we make sense of the answers—or what the inquirers of far-off days thought were answers. To achieve this task, Dr. Crombie reviews in turn the science of Western Christendom up to the renaissance of the twelfth century; the subsequent reception of Græco–Arabic science; and the flowering of scientific thought born of this fertilizing influence. Stepping back from the stream of history, he surveys the relations of science and 'technics' throughout the whole medieval period, and concludes his review of that period by a careful study of the gradual undermining of the Aristotelian authoritarianism (in this sense, as Whitehead reminded us, Aristotle was not an Aristotelian) within the medieval period itself. The last section of the book—running to well over a hundred pages—is devoted to the revolution in scientific thought during the sixteenth and seventeenth centuries.

It is impossible within the compass of this notice to do justice to the wealth of evidence provided in support of Dr. Crombie's implicit claim that whatever faults there may have been in medieval thought—and he does not deny that there were some—it was certainly not 'stationary'. The twenty pages devoted to bibliography include references to general works in the history of science, more detailed studies of special fields, and a representative selection from the periodical literature in English, French and German. These include numerous modern texts of original medieval sources. The iconographical sources—so important in this period—are represented by twelve plates and fifty text figures: these are admirably selected, and many are from manuscript sources not readily accessible. Something, however, has gone wrong with the legend to Fig. 1 (p. 53), where the Latin would have shocked even the 'Scholastici barbari', and the cosmology represented is 'Aristotle's' only in an Aristotelian sense. Nor, if the examples on p. 138 are a fair sample, is it at all clear what Dr. Crombie means by calling them "excellent": the heart is much too small and placed (conventionally) on the left side of the body, while the representations of the gut and skeleton perhaps bear a slight resemblance to a frog's but none at all to a man's. In the admirably generous and discrete documentation (for a full apparatus of detailed references would be a burden to that 'general reader' whose perusal of the book is so much to be desired) I have found none but comparatively trivial mistakes; but "Principia Mathematica" (1687, not 1686) has an unfamiliar ring in connexion with Newton. One concession to the 'general reader'—the use of the term 'doctor' as a synonym for 'medical man'—is, I suggest, one which, especially during the medieval period, might well have been eschewed.

Not every chemist (nor every mathematician) will be flattered by Dr. Crombie's assertion that "chem-

istry, like physics, finally set out on its course of being reduced to a department of mathematics"; and at least one reader sees no reason to revise his opinion that, apart from a few exceptional men like Petrus Peregrinus and Theodoric of Freiberg, the medieval thinkers entirely misconceived, as had the Greeks before them, the true nature of experiment. The absence of detailed accounts of the disposal of apparatus and of the control of the sources of error seems to me sufficient proof that it was regarded merely as a means of verification, in striking contrast to, say, Newton's first letter on the "celebrated phaenomena of colours". But if here and there Dr. Crombie's enthusiasm may have outrun his discretion, his book is one which will set a standard for a long time to come. Its publication has removed for ever any excuse there may have been for ignorance of medieval scientific thought.

W. P. D. WIGHTMAN

GRASSLAND CULTIVATION IN BRITAIN

The Grass Crop

Its Development, Use and Maintenance. By Dr. William Davies. (Agricultural Series.) Pp. xiii+318+9 plates. (London: E. and F. N. Spon, Ltd., 1952.) 26*s*. net.

THE development, use and maintenance of grassland in Britain is a matter of vital national importance—an importance which is becoming more apparent with each pronouncement concerning the national economic position. Faced with the imperative necessity of increasing agricultural production, it is to the grassland that one must look in the main for greater supplies of meat, milk and dairy produce. What is more, grassland represents a vital factor in maintaining soil fertility as well as a means of actually building up fertility, thereby raising the level of corn and root-crop production which is so essential to survival.

The potential of production from grassland rightly cultivated is immense, and the picture is most ably portrayed by Dr. William Davies in his new book, "The Grass Crop", for he himself has been concerned with this crop both in the sphere of research as well as advisory work among farmers for more than thirty years. Allied to his own work on the subject, Dr. Davies, as director of the Grassland Research Station, is in close contact with all the problems of the subject and has widened his canvas by first-hand study in many countries abroad. As a result he has been able to present not only a skilful, scholarly treatise of the subject but also one which will have lasting value to farmers and students alike.

In the early chapters, the historical and ecological aspects of grassland are presented, and Dr. Davies has been successful in weaving into this section much of the philosophy of modern grassland farming. As he so rightly points out, grassland agronomy must have an ecological approach but one not confined to plant ecology, for due heed must be given to both the animal consuming the herbage and the soils producing it. There is, too, the complicating factor of climate which determines the growth of the crop as well as the manner in which it shall be used by the farmer. Thus, the approach to the subject has very wisely been that of the trinity of soil, sward and animal.

Advocacy of the ley system of farming is emphatic and well reasoned, and the target is set at twelve million acres while at the same time retaining the present acreage of field-crops in Britain. The achievement of this goal would enable the sheep population to be doubled and the cattle population increased by more than a third above the 1951 level. But what is more, the attainment of such standards would act as a stimulant to the whole of the agricultural industry. One has only to travel through those counties where the ley is regarded as the pivot of the rotation to realize the salutary effect upon crop production as a whole of the securing of first-class leys.

To accept the principles of ley farming is one thing—to put them into operation is vastly more difficult. So Dr. Davies gives skilled attention to the vital problems of choice of seeds mixture, the establishment of the ley and the influence of the grazing animal on the productivity of the ley as such. A chapter is devoted to a detailed description of the characteristics and agricultural value of the different species and strains of grasses and clovers, and there are chapters on lucerne and the controversial subject of herbs. Seed production, which offers not only a useful additional source of income for many British farmers but is also of vital economic consequence traditionally, rightly merits a special chapter. Particularly valuable are the chapters dealing with permanent grassland and the development of the marginal and hill lands of the country, for it is here that the untapped potential lies and where criticism can so rightly be directed at the conditions found to-day.

The book is completed with an excellent detailed bibliography, covering all aspects of the subject, and also a useful index. It is to be hoped it will have the wide reading public it so richly merits, for apart from the farmers and students for whom it is specifically written, all with an interest in British farmlands, be they geographers, historians or simply lovers of the countryside, will find fascinating and really worthwhile reading in its pages.

H. IAN MOORE

ORGANIC CHEMISTRY FOR THE HONOURS STUDENT

Organic Chemistry

By Prof. E. E. Turner and Dr. Margaret M. Harris. Pp. xi+904. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1952.) 50*s*. net.

THE writing of a single-volume treatise on organic chemistry inevitably calls for compromise among the rival claims on space arising from a multitude of interests. A purely objective approach is difficult or impossible to maintain, and text-books tend to differ as much in range and emphasis as in arrangement and style. The present authors recognize this: they do not conceal their particular interests, but rather give them prominence in an adequately broad setting. The emphasis is on stereochemistry, and with this deservedly major theme there is interwoven a systematic survey of organic compounds, lavishly illustrated by structural formulæ and enlivened by frequent discussion of reaction mechanisms.

To accommodate the beginner, the first chapter provides a general introduction and sets forth essential features of electrochemical theory. Thereafter the general subject is rationally developed on modern lines, but without neglect of the origin and evolution

of modern concepts. Natural products are given representative treatment in separate chapters dealing with carbohydrates, terpenes, steroids, vitamins and alkaloids, while topics such as carotenoids, tropolones, penicillins, anthocyanins and pyrrole pigments are introduced as sub-sections in the general text. Throughout, the aim is to equip the reader for specialist reading and to guide him towards the fringes of current research.

The book provides an excellent refresher course: it will also be widely consulted for its stereochemistry. Although the authors disclaim the intention of writing an examination text-book, the honours student can scarcely fail to find it a profitable study. Yet it requires critical reading, for on occasion the authors reach or imply conclusions which are not strictly warranted by the facts presented. For example, the conclusion that certain optically active alcohols which have the same rotational sign have also the same configuration does not follow from the context on p. 637; nor is it there explained what meaning is to be attached to "same configuration" as applied to benzylmethylcarbinol and ethyl β-hydroxy-β-phenyl-propionate. None the less, the book is written well and in a manner which captures and sustains interest. Despite its size—it is somewhat unwieldy—and the complexity of the formulæ, it is remarkably free from errors of printing. But one cannot commend the practice—here inconsistently applied—of denoting a ring-member by a symbol placed beside the ring-outline as if it were a substituent. In the alicyclic series this is an unsightly and unnecessary elaboration; in the heterocyclic series, where a valency count may not remove the ambiguity, it is a real and avoidable source of misunderstanding.

J. D. Loudon

STRUCTURE-ACTIVITY CORRELATION IN THE MAKING

First Symposium on Chemical-Biological Correlation, May 26–27, 1950

Sponsored by the Chemical-Biological Coordination Center of the National Research Council. Pp. v+415. (Washington, D.C.: National Academy of Sciences/National Research Council, 1951.) 4 dollars.

SINCE Crum-Brown and Fraser in 1869 ventured to present the relationship between the chemical constitution of a drug (*C*) and its pharmacological activity (φ) in the form of a pseudo-mathematical equation $\varphi = f(C)$, numerous attempts have been made to verify this relatively simple expression. That these efforts to find a rational basis for drug action have not resulted in overwhelming success is due to various reasons: for example, the meaning of *C*, the chemical constitution, has often been accepted with superficiality as the two-dimensional formulæ used in chemists' notebooks and not as an integrated collection of all the finer points of physical and chemical properties of the compounds under consideration; differences in the mechanism of action between drugs achieving the same end-effects have been frequently ignored, and the existence of receptor molecules, possessing, like the drugs, specificity of structure and reactivity, has rarely been taken into account; differences in the degree of accuracy between the measurements of biological effects and certain physical-chemical characteristics have been overlooked in many cases.

It is therefore not surprising that, during the past thirty years or so, most of the major advances in the field of biologically active substances have been made by trial and error and by fortuitous discoveries. Yet, here and there, groups of therapeutics were found which were more amenable to a rational treatment, and the emergence of the theory of antimetabolite action has given renewed impetus to the slowly moving searches. But there still remains the necessity for more and more data of biochemical, physicochemical and biological observations, the last-named as quantitative in nature as possible.

To provide such data the United States National Research Council founded in 1946 the Chemical-Biological Coordination Center. With lively optimism, so characteristic of many American undertakings, this body has developed procedures for the collection of data sheets, the preparation of card files and the use of chemical and biological codes. From time to time, accumulated results are published in the form of booklets. True, the chemical data are sometimes scanty and physical-electronic properties more than often missing. The biological results suffer from the fact that they belong to the plus–minus variety; but matters have progressed sufficiently to warrant, in May 1950, the arrangement of the first symposium on simply, perhaps over-simply, expressed "Chemical-Biological Correlation". The lectures and discussions were published during 1951, unpretentiously in varitype print, giving to everyone interested in the subject the chance to see for themselves how matters stand. There are a number of most stimulating contributions, such as that by Schubert on the effect of drugs on physiologically active thiol systems, and by Friedman on the influence of isosteric replacements upon biological activity. Others, experts in various special fields, like Doak and Eagle on arsenosobenzenes, Norman and Weintraub on plant growth-regulators, Lands on sympathomimetics, and Horsfall *et al.* on fungicides, have chosen a defined group of closely related substances to prove their case. Two lectures on antihistamines and antithyroids were used to demonstrate the procedures and the systems introduced by the Center and separately explained by its director, Dr. Kirner, and Drs. Beard and Geer. Two panels were discussing antimalarials and antimetabolites, carcinogenesis and cancer therapy. With regard to the first, one could quote F. L. Rose's statement on the occasion of his Tilden Lecture, "A Chemotherapeutic Search in Retrospect": ". . . the use of the 'working hypothesis' concept based on observation and the intelligent development of leads . . . must constitute the foundation for speculative research in this field for a long time to come". As to the wide and complex subject of antimetabolites, carcinogens and carcinolytic substances, only the antimetabolites seem to obey certain rules. The rationalization of conditions of cytotoxic compounds is more than ever waiting for the discovery of their true mechanism of action. But this problem, although a very thorny one, and those problems connected with drugs where the mode of action has been more fully elucidated, may yield sooner than expected at present if the attempts at producing and then collecting all pertinent data are vigorously continued; for, as Hales said at the beginning of the eighteenth century, "hardly do we guess aright at the things that are upon earth, and with labour do we find the things that are before us".

F. Bergel

Race Crossing in Man

The Analysis of Metrical Characters. By J. C. Trevor. Pp. iv+45. (Eugenics Laboratory Memoirs, 36. Galton Laboratory, University College, London.) (Cambridge University Press, 1953.) 12*s.* 6*d.* net.

CLASSICAL anthropology has been largely concerned with metrical characters such as stature, craniometric characters and the like. The published material on human race crosses has now been sifted and exhaustively and critically summarized in this monograph, which deals with hybrid American Negroes, Jamaican 'Browns', half-blood Sioux, Ojibwa-Whites, Yucatecans, the Rehoboth Bastaards, Kisar Mestizos, the Norfolk Islanders and Anglo-Indians. The data turn out to be surprisingly incomplete. In many cases the racial groups which have contributed to a hybrid population are more or less conjectural. The hybrid groups have thus to be compared with populations which may not represent the ancestors of the crosses at all accurately; this is particularly likely where the European component may have been a small number of individuals. In any event, the ratio in which Europeans and non-Europeans have contributed to a mixed population is usually quite unknown. Some of the measurements on living people with which this monograph deals are notoriously inaccurate, and different investigators may report different values for supposedly the same measurement; in many cases, the parental groups and the mixed population have not been measured by the same worker, at least not on an adequate scale.

Despite all these limitations, two facts seem to emerge as a general rule. Where two parent populations differ significantly for a given measurement, the mixed population tends to occupy a position more or less intermediate between the parental groups. Secondly, for any given character the variability of the hybrid population does not seem to differ strikingly from the variability of the 'pure' races which have contributed to the cross; if there is any difference at all, it is certainly not large. It thus rather looks as if, for the series of metrical characters considered, the parental 'races' have not been appreciably more homogeneous than the mixed populations derived from them. H. GRÜNEBERG

Rocks for Chemists

An Introduction to Petrology for Chemists and Students of Chemistry. By Prof. S. James Shand. Pp. xii+146+32 plates. (London: Thomas Murby and Co., 1952.) 21*s.* net.

THIS book may be briefly described as an introduction to the study of rocks, their mineralogical and chemical composition, and physico-chemical relationships. The author wishes to convince chemists that the problems of rock and mineral genesis offer a rich field for research.

A short historical introduction is followed by chapters dealing with rocks in the field, rock-forming minerals, the nature of lavas, and the classification of eruptive rocks. The inadequacies of non-chemical classifications and the chemical approach by grouping rocks as oversaturated, saturated, undersaturated, peraluminous, metaluminous, subaluminous and peralkaline are discussed, the limitations of entirely chemical methods of classification being duly stressed. Subsequent chapters deal with plagioclase rocks, dioritic rocks, granitic rocks, syenitic rocks, feldspathoidal rocks and heavy crystal accumulates, the treatment being adequately informative with a definite physico-chemical bias. When appropriate, phase diagrams are used for illustrating the text. Sedimentary rocks are allotted only one short chapter, and the final two chapters deal with metamorphic rocks.

'Multum in parvo' in a quite non-derogatory sense, the book provides a very readable and interesting summary of knowledge and ideas. A section on suggestions for reading is included. The thirty-two excellent plates, illustrating rocks in the field in hand specimens and under the microscope, are well chosen to stimulate interest. C. O. HARVEY

On the Metamathematics of Algebra

By Prof. Abraham Robinson. (Studies in Logic and the Foundations of Mathematics.) Pp. ix+196. (Amsterdam: North-Holland Publishing Co., 1951.) 18 f.

THE claim of Couturat, that mathematical logic would help mathematical research, was ridiculed by Poincaré in 1908, who said that logic, so far from lending mathematics wings, had only provided it with fetters. Since that time considerable progress has been made, both in logic and in abstract algebra, and Prof. A. Robinson now claims to have made a positive contribution to the latter subject by the methods of the former. The abstract algebra of fields, rings and similar structure seems more suitable for such treatment than any other branch of mathematics. Two main lines of attack are suggested. Instead of proving individual mathematical theorems, we may be able to show that any theorem of a certain class which is true for one type of mathematical structure is also true for another type. Prof. Robinson claims to have discovered three outstanding results by this method. Alternatively we may be able to develop a theory common to all structures based upon any one of certain systems of axioms, and some progress in this direction is also claimed.

Prof. Robinson's synthesis of algebra and "metamathematics" appears to be a new type of deductive technique which is capable of considerable extension to a variety of applications.

Introduction to Modern Prime Number Theory

By Dr. T. Estermann. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 41.) Pp. ix+75. (Cambridge: At the University Press, 1952.) 12*s.* 6*d.* net.

THE object of this tract is to enable mathematicians who are not specialists in the theory of numbers to learn some of its non-elementary results and methods without too great an effort. It assumes no previous knowledge of the subject beyond what is given in Hardy and Wright's "An Introduction to the Theory of Numbers". The tract consists of three chapters. The first deals with Riemann's zeta function and a refinement of the asymptotic formula for the number of primes not exceeding a given integer. The second chapter deals with primes in arithmetical progression, using Dirichlet's L functions, with many theorems on characters. The third chapter deals with the representation of an odd number as a sum of three primes, using the methods of Hardy and Littlewood, and an extension of them by Vinogradoff. The tract concludes with a list of ninety-six theorems and formulæ for reference, and with a very short index. The author seems to have done his best to simplify a difficult subject, but those new to it may be surprised at the complexity of the methods necessary to establish a simple result. H. T. H. PIAGGIO

AIR MOTION IN THE UPPER ATMOSPHERE

By Dr. R. S. SCORER
Imperial College of Science and Technology, London

ON February 6, 1953, a meeting, arranged by the Physical Society, was held in the Department of Meteorology, Imperial College of Science and Technology, London, under the chairmanship of Mr. J. A. Ratcliffe, to discuss the physics of the upper atmosphere. The present article describes, from the meteorologist's point of view, the major problem raised at the meeting.

Before any attempt was made to theorize about the motion of the air at great heights, it was necessary to sample its physical condition. Though it was possible to explain the propagation of the Krakatoa air-wave on the assumption that above the troposphere lay a stratosphere of uniform temperature up to infinity, the reflexion of explosion waves from a height of about 30 km. clearly indicated the existence of a layer in which the temperature increased upwards. This layer is now known to be kept at its high temperature—in places warmer than the air at the ground—by the absorption of a large part of the ultra-violet radiation from the sun by ozone, which is itself produced by this radiation. The ozone dissociates only slowly and can therefore be used as an indicator of the motion of the air at those heights. For example, if a column of air at the ozone levels is elongated vertically the absorption of the ultra-violet is increased: this happens over extra-tropical depressions. Again, the accumulation of ozone over the winter pole, where it is certainly not produced, shows that there is a persistent motion towards that region at the ozone levels. Measurements of absorption by ozone are fairly simple to make, and by comparing the intensity of absorption with the intensity of a nearby wave-length that is not absorbed by ozone when light from the zenith is observed at a large number of times around sunset, a knowledge of the levels from which the scattered light originates may enable an estimate of the vertical distribution of ozone to be made as a routine[1].

The temperature in the ozone layers is a maximum at about 50 km., and above this level it decreases very much as it does in the troposphere, and a minimum of temperature is reached in the region of 80 km. It has been possible[2] to obtain reflexions of radio waves from the *E*-layer, not far above this level, which show that the reflecting layer is not uniform. The non-uniformities are found to move horizontally with velocities of the order of 5–50 m./sec. Similar movements, often with much greater velocities, in one case as large as 1,000 m./sec., have been observed in the non-uniformities of the *F*-layer; but at those levels (around 200 km.) the motion is dominated by electromagnetic and viscous forces and little guidance can be obtained from ordinary dynamical meteorology about the causes of such movements. At levels below 120 km. however, those forces are not predominant in producing the motion of the air, which therefore moves under much the same influences as the air with which meteorologists ordinarily deal—below 30 km. It is of interest to discuss what meteorologists can say about the motion of the air in and below the *E*-layer. Since this layer lies just above the ozone layer, we must first discuss the condition of that layer.

Dynamical Influence of the Upper Atmosphere

Some deductions can be made from observations made at the ground. The semidiurnal pressure oscillation[3] greatly exceeds the equilibrium tide value, and resonance was suggested by Kelvin as the explanation. If the driving force is gravitational, the resonance must be so selective that the lunar tide is not similarly amplified. Two difficulties arise: first, resonance seems to be an incredible fluke; and second, meteorologists are unable to accept that the resonance is so selective. Holmberg[4] has explained how the fluke could have come about. He reminds readers that the pressure surge in the air actually drives the earth round and so overcomes dissipation in the ocean tides and other retarding forces. When, during its evolution to its present state, the rotation was reduced to the speed at which resonance occurred, further slowing down was prevented by this mechanism. The resonance is therefore to be expected and is no more improbable than the monthly rotation of the moon on its own axis, for example.

The second objection is based on the knowledge that the Krakatoa air-wave was greatly distorted by the wind systems in one passage around the earth. The damping is therefore very large for this cause, and the resonance is unlikely to be selective enough to exclude amplification of a larger lunar tide. But we may follow Kelvin and suppose that most of the energy is derived, not from tidal forces but from the temperature oscillations, in which the semi-diurnal component is large. The diurnal variation in amount of cloud and rainfall accentuates the temperature variations, and in many parts of the world there is a nocturnal as well as an afternoon maximum.

The 12-hr. resonant period is not the only possible one, and the 10½-hr. period, if it occurred, would be of much larger amplitude in the troposphere relative to its amplitude in the ozonosphere than the 12-hr. one. Since the energy is mostly put in in the troposphere, why did not the earth cease to slow down when its rotation period was reduced to 21 hr.? Perhaps it was never as small; or if it was, it was at a time when the temperature of the troposphere was much greater. But among other explanations is the possibility that most of the energy is put in in the ozonosphere, where the diurnal temperature variations must therefore be large. The point here is that the upper half of the ozonosphere probably behaves in many ways like the troposphere, and this argument reinforces belief that it does.

Further support is gained from the study of mother-of-pearl clouds. These are thought to form in the lower part of the ozonosphere in the crests of waves produced by the flow of a strong wind-current over a mountain range. In order that such wave motion should occur, the condition of the air at higher levels must be suitable, and one possibility is that the upper half of the ozonosphere is in neutral static equilibrium, that is to say, it is thoroughly stirred by convection currents—as is the troposphere.

Ordinary meteorological observations indicate no influence of the ozonosphere on the weather systems except in a rather indirect way. For example, Palmer[5] suggests that during a solar flare considerable ultra-violet radiation penetrates the ozonosphere and

warms the lower stratosphere, with important consequences to the weather. No direct dynamical influence on weather systems other than the two just mentioned has been inferred.

Dynamical Properties of the Upper Ozonosphere

If the motion in the troposphere were the same as the mean motion, it would be unstable. The nature of the instability, which can be studied theoretically, and which we will refer to here as the 'cyclone type', gives a clue to the mechanisms operating in the disturbances which are the departures of the actual motion from the mean motion, and there is reason for believing that these operate in a similar manner in the upper ozonosphere. But the results would be somewhat different. In the first place, there is no rigid boundary, and this would make it less likely that sharp surfaces of discontinuity of temperature and velocity, known as 'fronts' in the troposphere, would be generated. Another effect due to the earth's surface is that the diurnal variations of temperature occur mainly over the land, which forms only a small part of it. Heat is communicated to the air by convection currents from the surface. This convection goes on day and night over the oceans, while in the ozonosphere the heat is absorbed over a great depth of air—effectively perhaps 20 km. —and is all taken in during the hours of sunshine. It is to be expected, therefore, that the convection currents, which shall for convenience be called the 'cumulus type', would be on a much larger scale, geometrically, the largest being indistinguishable from the cyclones and anticyclones generated by the other mechanisms, while diurnal variations (in which are included the semi-diurnal) would be much more in evidence.

A static picture of the state of the atmosphere at these levels has been usually presented. In the troposphere and lower stratosphere, we know that the variations are very great and that at any one moment the temperature is very different from its average value. There is a continual exchange of air between the troposphere and the stratosphere by means of the disturbances of the cyclone and anticyclone type, although ordinary convection is restricted to the troposphere. Any vertical temperature gradients in the ozonosphere that may be measured cannot be taken as representative because there is no single state to represent. There is almost certainly a vigorous exchange of air, of a type that is hybrid between the towering cumulus and the cyclone, between the ozonosphere and the levels of the *E*-layer by means of convection currents, and these would presumably produce variations in the ionization concentration in the *E*-layer.

Meteorologists cannot at present be expected to develop the mathematics of these convection currents, for the theory of the disturbances we can readily observe in the troposphere is very rudimentary and observations are completely lacking in the ozonosphere. It is here that the observations on the size, diurnal variation and movements of the irregularities of ionization can help, for if they are due to these motions a scale can be set for them and we can begin to theorize.

Interpretation of Observations

Now that a fairly long series of observations on the movement of the irregularities is being accumulated, it is worth while to do more than speculate about the meaning of these movements. At first they were interpreted as winds, that is, bulk movements of the air as a whole. The daily variations first found at Cambridge have not been exactly repeated either at Washington or at Cambridge in another season, and obviously more observations are required before we can decide whether the supposition that the movements are winds is reasonable. We know that the diurnal influences are very strong; but a regular daily cycle of wind reversal is not what meteorologists would expect on the basis of observation of the air lower down, except that the semi-diurnal oscillation would be large at these levels; but that would not interfere with the convection and other circulations. This does not mean that the movements are not winds, but that we cannot easily be satisfied that they are; no meteorologist would be dogmatic at present.

The possibility that they represent some kind of inertial gravity wave motion transmitted through the air must be ruled out until an energy source for the wave motion has at least been suggested. Because of the enormous variety in wave-lengths and velocities that could be transmitted by the air, it is possible to 'explain' almost any motion in terms of waves so long as the wind velocity is not known, because the wave velocities depend so much on the wind structure.

If the movements are not of air but of ionization density, a cause for the non-uniformity may nevertheless be sought in the inhomogeneity of the air. The atmosphere is certainly well stirred up to 100 km. and probably higher by ordinary meteorological mechanisms; but since convection is the mechanism for the stirring, the inhomogeneities are on the scale of the convection. The inhomogeneities are mainly of ozone, water vapour and temperature (that is, density); whether these can produce variations of ionization of the observed kind is not for the meteorologist to say. When the irregularities have been created by air movements, they may yet follow a path dictated primarily by electromagnetic forces.

At much greater heights, in the *F*-layer, irregularities also appear and are similar in many ways; but the medium, being so rare and so highly ionized, does not behave like the fluid with which meteorologists ordinarily deal.

Conclusion

Observations, direct and indirect, indicate a mean profile of temperature with a maximum around 50 km. and a minimum around 80 km. In many respects the dynamical properties of the layer between are likely to be similar to those of the troposphere; but there are significant differences, the chief of which are the dominance of diurnal variations and the greater size of the convection elements. The actual temperature at any place and time probably differs greatly from the average, and it is the variations which are associated with the important dynamical processes.

At present, the only frequent observations being collected are the movements of the irregularities in the *E*-layer; and meteorologists hope that there is a connexion between them and air movements, however indirect, so that they will throw some light on the scale of the motion.

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[2] Phillips, G. J., *J. Atmos. Terr. Phys.*, **2**, 141 (1952).
[3] Wilkes, M. V., "Oscillations of the Earth's Atmosphere" (Camb. Univ. Press, 1949).
[4] Holmberg, E. R. R., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **6**, 325 (1953).
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A NEW AGRICULTURAL RESEARCH INSTITUTE

GLASSHOUSE CROPS, MUSHROOMS AND OUTDOOR FLOWERS AND SHRUBS

By Dr. E. E. CHEESMAN
Agricultural Research Council

ON the advice of the Agricultural Research Council, the Minister of Agriculture is founding an independent Agricultural Research Institute to promote research on the cultivation of glasshouse crops and mushrooms and of bulbs, flowers and shrubs grown commercially in the open. The announcement marks another step in the evolution of the Agricultural Research Service, and there is interesting history behind it (see also *Nature* of July 18, p. 89).

Forty years ago a group of nursery growers in the Lea Valley north of London were alarmed by the losses caused by pests and diseases on glasshouse crops and realized the need for research to be directed upon means of control. They formed the Nursery and Market Garden Industries' Development Society, Ltd., and, assisted by grants from the Ministry of Agriculture and from three local county councils, started a small experimental centre at Cheshunt.

The venture quickly proved its value, and acquired a reputation more than local. In 1923 the Ministry of Agriculture increased its grant to allow for increase of staff and more laboratory accommodation, on condition that the centre should extend its services beyond the Lea Valley to the glasshouse industry of the whole of Britain. The Experimental and Research Station, Cheshunt, then began to take the form it has to-day. The field of investigation widened to include studies of glasshouse soils with particular reference to the effects of partial sterilization by steaming or other methods, the physiology of glasshouse crops, and new techniques in glasshouse practice generally. The contributions of the Station, under the direction of Dr. W. F. Bewley, to increased production under glass have been set out in a series of annual reports, of which thirty-seven have been published.

When, after the Second World War, the National Agricultural Advisory Service was established, the Station, like other research institutes of similar origins, found itself relieved of direct advisory responsibilities to growers and freer to concentrate on the fundamental scientific questions that underlie the day-to-day practical problems of the industry. It was, however, not equipped to take full advantage of the change in emphasis.

By this time the facilities at Cheshunt had become inadequate for a national glasshouse research station. The Lea Valley had changed in character; the site was hemmed in by urban development and critical work was handicapped by the atmospheric pollution associated with the growth of Greater London. A move that would have been inevitable in any event was made more urgent by damage sustained by the Station during the War, which left the experimental glasshouses in bad condition.

A group appointed jointly by the Agricultural Research Council and the Agricultural Improvement Council to survey the post-war needs of research in the various branches of horticulture recommended that a new site should be found for glasshouse research, and that the opportunity should be taken to couple with it research into other commercial nursery crops for which no central facilities have hitherto existed, especially flowers grown out of doors.

A long search began for a site combining all the necessary features, one of which is proximity to an important local glasshouse industry. It ended recently with the acquisition of a hundred acres of land at Toddington, near Littlehampton, Sussex. Here the new Institute will begin its work with staff and apparatus transferred from Cheshunt and will have room to extend the Cheshunt programme in several directions.

The better light conditions for which the Worthing district is famous will make possible many studies of plant growth under glass on a scale hitherto impracticable. There is, for example, a promising field in the exact definition of the light and temperature requirements of glasshouse crops, which are known to vary between different varieties and at different stages of development for each variety. With facilities for critical experiments, the new Institute will be able to collaborate more effectively with the National Institute of Agricultural Engineering, which is working on glasshouse design and the control of glasshouse climate and so seeking to find the means of meeting the requirements of plants economically.

In developing new lines of inquiry, the Institute will not abandon the old, for the war against pests and diseases under glass still remains of major importance, and the study of new weapons and tactics deserves the better facilities that will be provided.

OBITUARY

Mr. C. D. le Maistre, C.B.E.

Some men achieve fame for the number of important jobs they have held; others, like Charles Delacour le Maistre, achieve their ambition by sticking to the same job throughout their working life, building up an organization or a movement from practically nothing to a mature and steadfast entity. The cause built up by le Maistre is that generally referred to as 'industrial standardization'; it has world-wide ramifications, and the national standards bodies set up in more than thirty different countries are directly or indirectly modelled on the British Standards Institution, which, in its earlier years, was built up under le Maistre's supervision. Born in Jersey in 1872, trained as an electrical engineer in South Kensington, he joined the small staff of the Engineering Standards Committee in 1902 and became its secretary in 1916, a post he retained until 1929. In that year the British Engineering Standards Association (the successor to the Engineering Standards Committee) received its Royal Charter, and le Maistre was appointed director. He was thus at the helm when the Association again changed its name, this time to the British Standards Institution, in 1931, and he finally retired from the Institution in 1943, having served as chairman of the Executive Committee during the year 1942–43.

Le Maistre's work in the international sphere, and still in the field of standardization, covered an even longer period, for he was appointed general secretary of the International Electrotechnical Commission on its formation in 1904 and still held that post at the time of his death, on July 5. He became seriously ill, for the first and last time in his energetic life, a few months ago, thus having to cancel his plans

for motoring to Yugoslavia for the meetings of the International Electrical Commission which were held in that country at the end of June. It was a great disappointment to him that for the first time in all these years he had to miss a meeting of the Commission. It will also be a cause of great regret to his many friends throughout the world that le Maistre has died before the jubilee celebrations of the Commission which are being planned for Philadelphia in 1954. He died just before he could be informed of the decision of the Commission to institute an annual lecture to be known as the Charles le Maistre Lecture, to be given by prominent personalities in the field of international standardization.

Charles le Maistre was a member of Council of Aslib for many years, and its chairman during 1949–50. During his association with Aslib, he became interested in the work of the International Federation for Documentation, and it surprised no one but himself that he very soon found himself elected president of the Federation, a post which he held with great distinction from 1946 until 1951.

He joined the Institution of Electrical Engineers as an associate in 1897 and became a full member in 1908. He was an associate member of the Institution of Civil Engineers, a member of the American Institute of Electrical Engineers, and a fellow of the City and Guilds Institute. He had served on the Council of the Institution of Electrical Engineers, and for his services in connexion with standardization during the First World War le Maistre was awarded the C.B.E. Among the foreign honours bestowed upon him were the knight commander (second degree) of the Royal Swedish Order of Vasa, honorary membership of the Royal Dutch Institution of Engineers and, quite recently, he was made a chevalier of the Legion of Honour (France).

Long after most men of his age would have claimed a well-earned rest after so active a life, le Maistre continued to thrive on work and he was constantly making journeys all over the Continent on behalf of the International Electrotechnical Commission or the International Federation for Documentation. When not abroad he regularly played squash, an energetic game even for a far younger man, and he devoted many of his leisure hours to his beloved bees. He took his hobby seriously and was chairman of the Surrey Beekeepers' Association during 1946–47.

Le Maistre had the happy knack of drawing the best out of all his colleagues, and his steadfastness of purpose earned him the respect of all with whom he came into contact. He firmly believed in his mission, not for the sake of standardization itself, but because he was convinced that the only salvation for mankind was the creation of a spirit of real understanding between individuals and between peoples, and the work on which he was engaged was a step in that direction. The foundations on which this work is now forging ahead in all parts of the world were indeed soundly laid by that pioneer Charles Delacour le Maistre.

J. F. STANLEY

NEWS and VIEWS

The Drummond Memorial Fund

WITH the object of commemorating the name and work of Sir Jack Drummond, who, together with Lady Drummond and their daughter Elizabeth Anne, were murdered on August 4 (see *Nature*, **170**, 229, 401; 1952), a Committee has been formed under the chairmanship of Lord Woolton, and over Lord Woolton's name an appeal has been issued. The members of the Committee are Lord Horder and Prof. E. C. Dodds, representing medicine; Sir Harold Himsworth, secretary of the Medical Research Council; Sir William Slater, secretary of the Agricultural Research Council; Dr. Norman Wright, of the Ministry of Food; Profs. A. C. Chibnall, G. F. Marrian and F. G. Young, representing biochemistry; Mr. Leonard Anderson, Dr. H. J. Channon, Sir Harry Jephcott and Mr. Wilfred Vernon, representing industry; and Dr. Ifor Evans, provost of University College, London. The Committee considers that the most suitable memorial would be an endowed Drummond Research Fellowship dealing with Sir Jack's main interest, namely, nutrition. A fund of about £25,000 is required, which will be administered by a body of university trustees, and the Fellowship will be tenable at any university or appropriate research institute. Subscriptions, whether by gift or covenant, should be addressed to the Drummond Memorial Fund, c/o Westminster Bank, Ltd., 154 Harley Street, London, W.1.

Applied Mathematics at Nottingham: Dr. Rodney Hill

THE Department of Mathematics at the University of Nottingham is expanding, and from the beginning of the 1953–54 session will include a professor of applied mathematics in addition to the professor of pure mathematics. Dr. Rodney Hill, now Research Fellow in theoretical mechanics in the University of Bristol, has been appointed to the new chair. His appointment at the early age of thirty-two is a fitting testimony to the outstanding work he has done in the relatively new and difficult field of mathematical plasticity. Dr. Hill graduated at Cambridge in 1941, and after a period spent in research there he joined the theoretical branch of the Armament Research Department. He returned to Cambridge after the War and worked there until 1948, when he became head of the Solid Mechanics Section of the British Iron and Steel Research Association laboratory at Sheffield. During his stay there he accomplished some notable work on the rolling and forming of metals. In 1950 he was appointed Research Fellow in theoretical mechanics in the University of Bristol, and there he collaborated with others engaged on theoretical and experimental investigations. His contributions to the theory of plasticity are contained in some thirty papers which he has written since 1945, either alone or in collaboration with others, and in a book, "The Mathematical Theory of Plasticity", published in 1950. This outstanding book is likely to remain for some time to come the standard work on the foundations of the subject. Last year he was appointed joint editor of the new international *Journal of the Mechanics and Physics of Solids*. The University of Nottingham can look forward to a period of development in applied mathematics and to the formation of close and valuable links with industrial research in Dr. Hill's field.

Notes and Records of the Royal Society

The recent appearance of the April number (vol. 10, No. 2) of *Notes and Records of the Royal Society of London* provides an opportunity of directing general attention to this valuable periodical. Hitherto addressed mainly to Fellows, it has gradually established itself as a medium for the publication of full articles on less well-known past Fellows, and also of more detailed notices of discoveries, which have cast a new light upon already well-documented lives. With the current issue the editor is circulating an appeal to Fellows to widen the search for MS. material and to enlist the interest of others who may be engaged on research into the history of the Society or of its past Fellows. The current issue, besides containing reports on the anniversary dinner and the Ramsay centenary, naturally emphasizes Sir Hans Sloane, the bicentenary of whose death falls this year. An article on Samuel Hartlib's influence continues the valuable series of studies, by various authors, of the circumstances of the foundation of the Royal Society. Those whose interests are rather literary than scientific will also do well to keep an eye on *Notes and Records*: in the current number Dr. Johnson's scientific affinities are shown to have been greater than is commonly realized, and M. de Voltaire appears in an engaging light in the "Journal" of John Morgan, an American Fellow. Following an account of the outstanding Keynes Collection of Newtoniana in the previous issue, we are in the current one provided with a concise but fully catalogued summary of the archives of the Cavendish Laboratory. *Notes and Records*, indeed, seems admirably adapted to become one of the much-to-be-desired meeting grounds for devotees both of the natural sciences and humanities. In its finely printed pages historians will scarcely fail to find valuable material; and others, less pragmatically, perhaps even more valuable entertainment.

Irish National Committee for Geodesy and Geophysics

An Irish National Committee for Geodesy and Geophysics was established in 1952 with headquarters at 44 Upper O'Connell Street, Dublin. The Committee was established in accordance with the recommendation of the International Union of Geodesy and Geophysics, of which Ireland, through the Department of Industry and Commerce, has been a member since 1939. The Minister for Industry and Commerce, Mr. Sean F. Lemass, appointed Mr. J. C. B. MacCarthy, of the Department of Industry and Commerce, to be chairman of the Committee. Represented on the Committee by one member, whose name is given in brackets, are the following institutions: Irish Meteorological Service (Dr. M. Doporto); Royal Irish Academy (Prof. J. J. Dowling); Seismological Observatory, Rathfarnham Castle (Rev. R. E. Ingram, *S.J.*); University College, Cork (Prof. J. J. McHenry); St. Patrick's College, Maynooth (Rev. P. J. McLaughlin); Ordnance Survey (Lieut.-Col. J. E. Nolan); University College, Dublin (Dr. P. J. Nolan); Geological Survey (Mr. M. V. O'Brien, director of the Survey); University College, Galway (Prof. C. O. Brolchain); Department of Agriculture (Mr. S. O. Meallain); Dublin Institute for Advanced Studies (Prof. L. W. Pollak); Trinity College, Dublin (Prof. J. H. J. Poole). The Committee meets about four times a year, and the matters which have so far engaged the attention of the Committee include hydrography, the Irish bibliography for hydrology, geodetic levelling and methods of accurate computation of mean sea-level for Ireland. The means by which the Committee can most effectively discharge its functions have been under consideration, and the Committee or individual members thereof will welcome communications from scientific bodies or persons interested in any of the branches of science covered by the International Union.

Botanical Society of Bengal

The seventeenth annual general meeting of the Botanical Society of Bengal was held on May 16 in the Department of Botany, University of Calcutta. Dr. R. Ahmed, Minister for Agriculture and Co-operation, Government of West Bengal, who was chief guest, spoke on the difficulty of inducing the Indian farmer to adopt the seeds, manure and equipment developed as a result of modern research. Consequently in India there is a great gap between the scientist in his laboratory and the worker in the fields. Dr. J. C. Sen Gupta, president of the Society, spoke of "Some Aspects of Recent Studies on Plant Growth Substances". In his review he recalled the considerable improvements in the field of agriculture, made possible by the application of particular hormones at particular stages in the life-history of the plant. Some recent discoveries of certain growth-substances of root, stem, leaf and flower have been utilized in such varied aspects as the increase of fruit yield, the induction of seedless fruits, the causing of biennially fruiting trees to bear annually, the defoliation of plants, the prevention of leaf-fall, the control of weeds and the like.

Sjta. Mridula Datta, hon. secretary, presented the annual report of the Society. During the year greater interest has been aroused by holding the meetings at different centres of botany. Consequently the membership has increased. Two issues of the *Bulletin* have been published. The following officers were elected for 1953–54: *President*, Dr. J. C. Sen Gupta; *Hon. Secretary*, Sjta. Mridula Datta; *Hon. Treasurer*, Sri P. K. Bose; *Editor of Publications*, Prof. S. R. Bose; *Secretary Foreign Correspondence*, Sri A. K. Ghosh; *Hon. Librarian*, Sri J. K. Sen.

Specifications for Insecticides

The World Health Organization Expert Committee on Insecticides devoted its fourth session to a general revision of specifications for substances used in controlling insect vectors of disease. The report on this session appears as No. 54 in the World Health Organization Technical Report Series (pp. 94. London: H.M.S.O., 1953. 5*s*.). New standards have been adopted for the following insecticides: technical DDT, technical benzene hexachloride (BHC) and its concentrates, technical methoxychlor, technical chlordane, water-dispersible powder concentrates of DDT and of BHC, and DDT emulsion concentrates. Technical dieldrin, pyrethrum extract, and certain emulsion concentrates were among other substances considered for which standards were formulated. Throughout this work the committee was at pains to specify only one test method—the simplest possible—for the determination of a given property. Although it is as yet unable to recommend a single control-test for the determination of sedimentation-rates for most water-dispersible powders, it has perfected such a test for the dispersible-powder forms of DDT. Specifications for aerosols, diluents, solvents and emulsifiers, as well as certain data on the preservation

of insecticides under various climatic conditions, are also given in the report. In addition to the description of test procedures, the annexes contain sampling instructions, and an account of a provisional method for testing aerosols which has been successfully employed in the United States of America. For those—whether manufacturers or buyers—who are obliged to keep abreast of the latest developments in this field, this report is a valuable source of information.

Register of Specialist Indexers

To assist authors and publishers in achieving a high standard of indexing in their published works, Aslib (formerly the Association of Special Libraries and Information Bureaux) is establishing a register of specialist indexers. The register will consist of persons who are available for part-time indexing only; a staff employment register is already maintained for indexers and other library staff seeking full-time employment of either a temporary or permanent nature. Indexers will be enrolled in two categories: those who can produce evidence of indexing ability, and those who appear to possess the necessary qualifications but who have no published indexes to their credit. In both cases, evidence of special knowledge of one or more subjects will be required, so as to ensure competence in handling technical and other specialized material. All indexing work negotiated through the Aslib register will be subject to scrutiny and report as a means of ensuring that the register becomes and remains a recognized source of reliable subject indexers. Inquiries should be addressed to the Director, Aslib, 4 Palace Gate, London, W.8. Under the terms of the register, which is licensed annually by the London County Council, no charge will be made to employers but a small enrolment fee and commission will be charged to those indexers who are accepted for enrolment, unless they are personal members of Aslib, when no charge will be made.

High-Altitude Research Laboratory in Alaska

A PERMANENT high-altitude observatory for research in cosmic radiation, high-altitude biology, and meteorology is in the course of being established on the summit of Mt. Wrangell (14,006 ft.), a dormant volcano in Alaska, by an expedition led by Dr. Serge A. Korff, professor of physics in New York University, and Dr. Terris Moore, president of the University of Alaska (see *Nature*, June 27, p. 1140). It has now been announced that a party of five has climbed the mountain on foot, arriving at the summit on July 1. It included Arthur Beiser and Hugo Neuburg, graduate students of New York University; Charles Wilson, of the University of Alaska; Philip Bettler, of the Geophysical Institute; and Robert Goodwin, of Anchorage. They were the second group ever to reach the summit, the first successful ascent having been made in 1908. Two Jamesway huts and related supplies and equipment have been dropped to the party by a private plane piloted by Dr. Moore. One of the huts is used as living quarters by the research workers; the other is a laboratory housing scientific supplies and equipment.

Solar Variation and Precipitation at Peoria, Illinois

A PAPER entitled "Solar Variation and Precipitation at Peoria, Illinois" has been published by Dr. C. G. Abbot (Smithson. Misc. Coll., **117**, No. 16; Sept. 3, 1952), in which he returns to the subject of twenty-three periodic changes in the intensity of the solar radiation, a problem to which attention has already been directed (Smithson. Misc. Coll., **117**, No. 10; 1952). Dr. Abbot has been engaged for more than three years in investigations of precipitation records between 1856 and 1939, and in the present paper shows that periodicities of the same length as nineteen of those discovered in solar variation are accompanied by changes of 5–20 per cent amplitude in the precipitation at Peoria. Four graphs show how these periodic variations of precipitation occur in nearly equal amplitudes and with moderate differences of phase in twelve separate independent intervals, each several years long. Using these results as a basis, predictions of the precipitation for Peoria during 1940–50 are made and the results are very satisfactory. The actual precipitation ranges from 50 to 150 per cent of normal, and prediction matches the event for eight out of eleven years to within an average deviation of 14·7 per cent. Large fluctuations in precipitation during the other three years were matched by similar large fluctuations in the curve of prediction, but with phase differences varying from three to six months. It is admitted that it is difficult to understand how solar changes generally less than 0·2 per cent can produce variations in precipitation of 5–20 per cent; but, in spite of this, these periodic changes of precipitation have been synthesized to forecast seasons. One of the graphs in the paper shows the predicted precipitation at Peoria during 1940–50, and for the first three years there is fair agreement between prediction and event; but after 1942 there was change of phase, though not of form, and changes of phase mar long-range predictions. Dr. Abbot adds at the end of the paper that, unless the phase-changes can be anticipated, the method of prediction fails to come up fully to expectation.

Library of the University of Leeds: Annual Report

THE annual report of the librarian of the University of Leeds for the session 1951–52 (pp. 16; 1952) records holdings on June 30, 1952, of 351,847 books and 155,278 pamphlets; accessions during the year numbered 14,130 and 3,564, respectively, and, compared with the first year of the quinquennium just ended (1947–48), the total stock increased by 20 per cent and annual accessions by 28 per cent, due partly to increased book funds, especially in the form of non-recurrent grants from the University Grants Committee and from the Council. The rate of additions to the catalogue increased by 144 per cent, and the growth of the main author catalogue presents a serious problem of accommodation. Binding increased in bulk by 62 per cent and is now limited chiefly by finance. The annual number of loans increased by 56 per cent, and inter-library loans were developed as a matter of policy; the Library borrows extensively from other libraries in the region and throughout Britain and abroad, and lends extensively in return, especially to other universities and to public libraries in the Yorkshire Regional Library System. Hopes that during the new quinquennium a systematic effort could be made to fill some of the more serious gaps in the collections are unlikely to be realized, and it is probable that a main concern will be to avoid an undue decrease in the intake of current publications in view of the constantly rising cost of books. The successful display of French scientific publications was followed in January 1952 by an equally successful exhibition of Dutch learned publications.

Physics of Fibrous Materials: Symposium in Arnhem

A symposium on the physics of fibrous materials was held under the auspices of the Dutch Physical Society during October 5–6, 1950, at Arnhem. The original intention to publish the proceedings of the symposium in the *Nederlands Tydschrift von Natuurkunde* proved impracticable; but, with the assistance of the editors of *Rayon Revue*, a report in English has at length been published ("Physics of Fibrous Materials". Pp. 107. Arnhem: N.V. International Rayon-Verkoopkantor). The illustrated booklet contains the introduction to the symposium delivered by P. H. Hermans, the chairman of the symposium committee, and nine papers as follows: fibrous materials from the physical point of view (J. M. Goppel); X-ray diffraction analysis of fibrous materials (A. Weidinger); deformation mechanisms (P. Dekking); longitudinal abrasion of elementary filaments (V. E. Gonsales, the secretary of the symposium, this paper being a shortened version of an article in the *Textile Research Journal*, **20**, 28; 1950); behaviour of fibres as they glide (H. L. Röder); physical problems in textile research (J. R. H. van Nouhys); determination of the irregularity of slivers, rovings and yarns (F. H. Germans); high-frequency drying in the rayon industry (R. van Nes); and drying of textile materials with the aid of infra-red radiation (H. J. Selling). Brief discussions are appended to each paper.

Classification of Rubber Literature

A revised system of classification of information on rubber has been agreed upon jointly by the Research Association of British Rubber Manufacturers, the Rubber-Stichting, Delft, and the Institut Français du Caoutchouc, Paris, for use by all associated institutions in Europe and in the Far East. The system, which is primarily a classification by material and not by article of manufacture, is based on the classification used in the monthly periodical, *Rubber Abstracts*, of the Research Association of British Rubber Manufacturers; and this body has issued, as Information Bureau Circular No. 410, a copy of the system, printed as duplicated sheets, which is obtainable on application to the secretary (105–7 Lansdowne Road, Croydon, Surrey). It is proposed eventually to issue the system in a printed form, and also in French and German versions, together with an index, now in preparation; but librarians and rubber technologists are invited to submit comments and suggestions before it is committed to print.

An Orchid Flora of Guatemala

The "Flora of Guatemala", by P. C. Standley and J. A. Steyermark, is being published by the Chicago Natural History Museum over a period of years. The first volume of the "Orchids of Guatemala", by Oakes Ames and Donovan Stewart Correll, has now appeared (*Fieldiana*: Botany, **26**, No. 1). The second volume is promised for the near future. Guatemala, with some eight thousand species of vascular plants, is a very rich and varied floristic region and has long been recognized as a happy hunting ground for orchid collectors. A large number of species has now been recorded. During the period 1938–42, Standley and Steyermark, as part of a general collection, collected some 323 species and 19 varieties of orchids, distributed among 68 genera, of which 3 genera, 38 species and 4 varieties were new to Guatemala and 8 species were new to science. In all, some 527 species in 89 genera have been recorded in Guatemala. This new orchid flora contains an introductory essay in which the authors point out that the wet rain forests of Alta Verapaz, with abundant rainfall all the year round, have yielded some 242 species in 60 genera of orchids, as well as many Bromeliaceæ. The rain forests of the Atlantic coast are also rich in orchid species. The distribution of orchids in the several floristic regions is briefly indicated. The largest genera in Guatemala are *Epidendrum* (87 species), *Pleurothallus* (55 species), *Spiranthes* (35 species), *Oncidium* (33 species). Some 57 species in 23 genera occur only in Guatemala; but only one monotypic genus is known to be endemic there. Some species are found at high altitudes, up to 13,000 ft. Keys to the tribes, genera and species are given, and many species are illustrated by line drawings.

Ascospore Dimorphism

An account has been given by M. J. Mathieson (*Annals of Botany*, N.S., **16**, 64; 1952) of ascospore dimorphism and mating type in *Chromocrea spinulosa*. The asci contain four large and four small ascospores, each two-celled, arranged in the six patterns expected if spore size were controlled by a pair of allelic genes, the locus showing 65 per cent second-division segregation. The small ascospores produce sterile colonies, the large ones moderately fertile colonies, the asci of which again show segregation for spore size. Fertility is stimulated where colonies from large and small spores meet. In crosses of various mutants with the wild type, all asci in perithecia developed along the line of junction show segregation for the mutant as well as for spore size. Evidently *Chromocrea* is heterothallic, the spore-size difference being a pleiotropic expression of mating type. One allele, that governing large spores, occasionally mutates to the other allele, resulting in fertility of colonies from large spores.

Stories in Hair and Fur

A temporary exhibition arranged by the Cranbrook Institute of Science, U.S.A., to illustrate the sources and biology of hair and fur and man's uses of them for protection and other purposes has been transferred to Britain for circulation by the Museums Association (Meteorological Buildings, Exhibition Road, London, S.W.7). The cost of bringing the exhibition across the Atlantic and printing booklets and posters was met by the Fur Trade Information Centre. The exhibition consists of thirty-one panels designed to be hung on open screens (except in the case of thirteen which require the protection of glass or a handrail) and supplementary skins.

Technical Certificate of the Museums Association

The Museums Association has now approved finally the details for the establishment of a certificate for proficiency in technical matters. The drawing up of a scheme has proved a difficult task, not least in avoiding misunderstanding as to its purpose caused by the widely different ways in which the term 'technical' is employed in describing museum posts. The certificate will be given for competence in the preparation, restoration and practical display of museum exhibits, including natural history, archæological and geological material, water-colours, drawings, prints, frames, ceramics, glass, furniture, metal-work, costumes, needlework, and textiles. It

is hoped that in the future it may be possible to arrange special training courses for candidates; but at present it is assumed that they will obtain the necessary knowledge and experience in the course of their normal duties. Other than the registration and examination fees, the candidate will not be liable for any other expenses.

Grants for Research in Experimental Psychiatry

THE Rockefeller Foundation of New York has made a grant of £28,800 to the Department of Experimental Psychiatry, University of Birmingham, for research in psychiatry, and the biochemistry and pharmacology of the nervous system. The department was founded in October 1951. Its aim is the application of experimental method to problems of clinical psychiatry. The problems under investigation at present are essentially neurochemical and neuropharmacological. It is, however, hoped to develop systematic studies into the preventive and social aspects of psychiatry as well. An Early Treatment Centre (comprising in-patient, day-patient and out-patient facilities) is being planned, and should, when complete, provide a suitable setting for studies of this kind.

Government Grants for Nuclear Research in Sweden

THE Government of Sweden has announced that it is making grants totalling Kr. 1,500,000 (that is, about £100,000 or 300,000 dollars) to be spent during the budget year of 1953–54 on nuclear research in Sweden. Among the various kinds of research for which the money is intended are included the following: additional grant for the building of a Van de Graaff generator at the University of Lund; costs for the operation of the high-tension laboratory of the Karolinska Institutet, Stockholm, and for emanation experiments at the same institute; research into the beta- and gamma-radiating elements stored in the human body; synchrotron laboratory experiments and electronics experiments at the Tekniska Högskolan in Stockholm; and other aspects of nuclear chemistry and nuclear physics at various institutions.

Chemical Engineering Conference

THE Institution of Chemical Engineers and the Chemical Engineering Group of the Society of Chemical Industry are organizing a Chemical Engineering Conference to be held during September 7–11, at Olympia, London, at the time of the Engineering, Marine and Welding Exhibition and the Chemical Plant Exhibition. The Conference will be open to all visitors to the Exhibition. The programme includes papers on carbon and graphite as materials of construction for chemical plant, production and properties of tantalum and zirconium, developments in the production of chlorine with special reference to mercury cells, recent advances in milk processing plant, evaporation with particular reference to heat-sensitive liquids, recent advances in distillation, production of formaldehyde from methanol by the silver catalyst process, and application of plastics to chemical plant. There will also be a discussion on British chemical engineering in the light of recently published reports, to be opened by Sir Harold Hartley and Mr. J. Grange Moore.

Seventh Congress of the International Scientific Film Association

THE seventh congress of the International Scientific Film Association will be held during September 18–27 in the National Film Theatre and Royal Festival Hall, London, S.E.1. During this period there will be meetings of the general assembly of the International Scientific Film Association, of the permanent committees dealing with medical, research, technical and industrial films, as well as the usual Festival of Scientific Films. A special committee of the British Scientific Film Association will consider and recommend films for submission to the Festival; full details of films should be sent, including title, running-time, gauge, date of production, brief synopsis, etc. In addition, the Association would be glad to have details of research and record films of specialized types, which need not necessarily be in the form of complete titled 'films', for showing at meetings of the permanent committees dealing with medical, research, technical and industrial films. Special meetings and film shows will be devoted to the technique and application of films in medicine; further particulars may be obtained from the vice-chairman of the Medical Committee, Dr. R. C. MacKeith, Guy's Hospital, London, S.E.1. Information about the Congress as a whole can be obtained from the General Secretary, Scientific Film Association, 164 Shaftesbury Avenue, London, W.C.2.

Science and Applications of Photography

AN international conference on the "Science and Applications of Photography" is being organized by the Royal Photographic Society of Great Britain and will be held at the Institute of Education (London University), Malet Street, London, W.C.1, during September 19–25. The provisional programme includes public lectures by Dr. C. E. Kenneth Mees and by Dr. R. M. Evans, Color Control Division, Eastman Kodak Company, both to be delivered at the Royal Institution, Albemarle Street, London, W.1, and five sessions of sections for the presentation of papers and for discussion. Membership of the Conference is open to all; the fees are, for members of the Society and lecturers £1 1*s*., and for non-members £2 2*s*. This includes one set of preprints of the papers presented in any one of the five sections of the Conference; preprints of papers in other sections can be obtained on payment of an additional 5*s*. for each section. The full text of the papers will also be available in microfilm or similar form. Further particulars can be obtained from the Secretary of the Royal Photographic Society, 16 Princes Gate, London, S.W.7. The annual congress of the International Scientific Film Association is being held in London during approximately the same period, and reciprocal arrangements are being made to enable members of each to participate in the activities of the other, without additional fees.

Third International Congress of Electroencephalography and Clinical Neurophysiology

THE Third International Congress of Electroencephalography and Clinical Neurophysiology will be held in Boston at Agassiz House, Radcliffe College, Cambridge, Mass., during August 16–21. Besides the scientific sessions there will be six symposia on, respectively: recent developments in electroencephalographic techniques; the physiological basis of the encephalogram; the interpretation of the encephalogram; evaluation of activation of the electroencephalogram; interrelationships between cortex and sub-cortical structures; and characteristics and significance of seizure discharges. Further information regarding the Congress can be obtained

from the secretary-general, Dr. Robert S. Schwab, Massachusetts General Hospital, Boston 14, Mass.

Fourth Anglo-American Aeronautical Conference

The Fourth Anglo-American Aeronautical Conference will be held in London during September 15–17. The subjects of papers to be discussed include the control of flight, structure of high-speed aircraft, fatigue of aeroplane structures, helicopter design, pod mounting of turbo-jet engines, boundary layer control, structural adhesives for metal aircraft, thermal de-icing, aerodynamics of compressor blade vibration, power plants for helicopters and delta aircraft. The Conference is open to members of the Institute of the Aeronautical Sciences, and members of the Royal Aeronautical Society, 4 Hamilton Place, London, W.1, from which further particulars can be obtained.

Summer School of Physics

The Italian Physical Society, under the auspices of the Ministry of Education and the National Research Council, is organizing an international school of physics, to be held at the Villa Monastero, Varenna, Lake Como, during August 19–September 12 under the direction of Prof. Giampietro Puppi, professor of theoretical physics in the University of Bologna. The subject to be considered will be problems relating to the detection of elementary particles, with special reference to cosmic radiation, and the three individual topics and the respective lecturer will be as follows: the cloud-chamber method, Prof. P. M. S. Blackett (Imperial College of Science and Technology, London); nuclear emulsion method, Prof. C. F. Powell (University of Bristol); and primary cosmic radiation, Prof. H. Alfvén (Institute of Technology, Stockholm). All lectures and the accompanying seminars and discussions will be conducted in English or French. The school will be limited to 20–25 persons. The fee, including full board, will be 30,000–35,000 lire. Application forms should be sent before July 30 to Prof. G. Puppi, Società Italiana di Fisica, Via Saldini 50, Milan, Italy, from whom all further information can be obtained.

Lectures by Members of the Everest Expedition

The Royal Geographical Society and the Alpine Club, by arrangement with Wilfred Van Wyck, are organizing twelve illustrated lectures on "The Ascent of Everest", to be given at the Royal Festival Hall, London, S.E.1, on the evenings of September 15, 16, 18, 19, 21, 22, 23 and 28, October 13 and November 2, at 8 p.m., and on the afternoons of September 19 and October 10 at 3 p.m. The lectures will be by Colonel Sir John Hunt, leader of the Everest Expedition, Sir Edmund Hillary, A. Gregory, Major C. G. Wylie, W. G. Lowe, T. D. Bourdillon and C. W. F. Noyce. The proceeds from the lectures, and from those to be given in the provinces and abroad, will go to a trust fund for exploration in mountain regions. The first evening, September 15, will be a gala event, for which further details will be announced in due course. Tickets for the lectures (prices 15*s.*–3*s.* 6*d.*) will be on sale at the Royal Festival Hall and the usual agents as from July 27. Further information can be obtained from the Secretary of the Royal Geographical Society, 1 Kensington Gore, London, S.W.7.

The Night Sky in August

New moon occurs on August 9d. 16h. 10m., U.T., and full moon on August 24d. 20h. 21m. The following conjunctions with the moon take place: August 5d. 03h., Jupiter 4° S.; August 6d. 02h., Venus 5° S.; August 8d. 02h., Mercury 3° S.; August 15d. 11h., Saturn 8° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Mars on August 23d. 14h. Mercury is too close to the sun to be seen during the early portion of the month, but towards the middle of the month it rises about 3h. 10m. and may be seen for a short time before sunrise, stellar magnitude 0·1; after this it approaches the sun and on August 31 rises only forty minutes before sunrise. Venus, a morning star, rises at 1h. 10m., 1h. 20m. and 1h. 50m. on August 1, 15 and 31, respectively; the visible portion of its illuminated disk varies between 0·67 and 0·78, and its stellar magnitude averages − 3·5. Mars rises at about 3h. 40m. throughout August and is not well placed for observation, as it is rather close to the sun, until the end of the month when it rises more than an hour and a half before the sun; about August 9 it lies nearly midway between δ and γ Cancris, but will not be easily seen at that time. Jupiter rises at 0h. 30m., 23h. 40m. and 22h. 50m. at the beginning, middle and end of the month, respectively, stellar magnitude about − 1·8; after the middle of the month it will be seen a little north of ζ Tauri, which it approaches during its slow easterly movement. Saturn sets at 22h. 15m., 21h. 20m. and 20h. 20m. on August 1, 15 and 31, respectively, and lies about midway between α and ζ Virginis and a little east of θ Virginis. A partial eclipse of the sun, greatest magnitude 0·372, occurs on August 9, but is invisible at Greenwich. The Perseid meteor shower attains a maximum during August 10–12. Only one star brighter than magnitude 6 is occulted during the month, 49 Sgtr. disappearing on August 21d. 23h. 02·8m.

Announcements

The College of Physicians of Philadelphia has awarded the Alvarenga Prize for 1953 to Dr. F. D. Moore, surgeon-in-chief in the Peter Bent Brigham Hospital and Mosely professor of surgery in Harvard Medical School, for his outstanding contributions to knowledge of the changes in body metabolism following surgery. The Alvarenga Prize is an annual award established in 1883 by the late DaCosta Alvarenga, of Lisbon, Portugal, an associate fellow of the College.

The following resignations have been announced from the University of Sheffield: Prof. E. J. Wayne, from the chair of pharmacology and therapeutics, on his appointment as regius professor in the practice of medicine in the University of Glasgow; and Dr. H. J. Cowan, lecturer in civil engineering, on his appointment to the chair of architectural science in the University of Sydney. Mr. J. F. Fleming has been appointed lecturer in civil engineering in the University.

The University of Padua is offering a Gabriella Zuccari scholarship of 300,000 lire for research of at least seven months duration at the Zoological Station, Naples, during 1954. The scholarship is open to any person who wishes to undertake research in zoology, comparative anatomy, physiology or embryology, and it may be renewed up to a maximum of three years. Application forms (to be returned by October 31) and further information can be obtained from the Secretariat of the University of Padua.

UTILIZATION OF RADIATION FROM FISSION PRODUCTS

A SYMPOSIUM on the use of fission-product radiation was held by the Chemistry Division at the Atomic Energy Research Establishment, Harwell, during February 23–24. Invited representatives of the chemical and pharmaceutical industries and of those interested in using radiation for food preservation and medical purposes attended the meetings in addition to members of Harwell and of the Radiochemical Centre, Amersham, and the Production Branch of the Directorate of Atomic Energy. The object of the symposium was to decide what steps should be taken now by the Directorate and by potential users if fission-product radiation is to be used fully in the national interest.

In his introduction, Dr. R. Spence (chief chemist at Harwell) said that we should expect by 1970 that the output of fission products could be of the order of one ton per year, representing 2×10^{10} MeV.-curies (equivalent to 120 MW.) from the fission-product radiation alone. Even if this energy were used with only 1 per cent efficiency, this represents a considerable power output for such a unique form of energy. Storage of this active material would represent a serious embarrassment to the atomic energy project, and use of the radiation energy from these by-products could reduce the cost of nuclear power.

The first part of the symposium was concerned with the nature of the fission-product sources and with ways of using the radiation energy. In a paper on the use of gamma radiation from reactor fuel rods, Dr. W. Wild and J. Wright (Harwell) discussed ways of storing fuel rods during their 'cooling' period (between irradiation and chemical processing) so that the emitted gamma radiation could be used. Without any interference with present operations, the 70 per cent of the total gamma radiation which is emitted during this period can be used to give dose-rates up to 10^4 r./min. A nuclear power station producing 240 MW. of electrical power would provide enough fission products to treat 2,000 tons of material per day with a dose of 10^6 r.

A paper by Dr. C. B. Amphlett (Harwell) dealt with the use of the radiation from fission-product wastes and showed that use of the beta energy from the solutions left after chemical processing depends upon fabrication of suitable irradiation vessels with thin partition walls. Calculations of the yield of chemical products obtainable with selected geometrical arrangements show that the most suitable radiation chemical processes for industrial use of fission-product energy would be chain reactions of high yield such as polymerizations, or reactions contributing to the synthesis of some expensive product required only in relatively small quantities. Reactions with yields of less than 10 molecules per 100 eV. of energy absorbed are unlikely to compete in output with orthodox chemical industry.

By separating active fission products from inactive material very high specific activity can be obtained so that self-absorption in the source is reduced to a minimum. The total production of many of the longer-lived fission products can be utilized efficiently throughout much of their life, leaving relatively inactive end-products. This was discussed by G. N. Walton (Harwell) in a paper on the specific activity of separated fission products from reactor fuels. Following the principle that the shorter the life of the fission product concerned, the less is the mass of material involved in the transfer of power, calculations were made of the power which would be carried by short-lived rare-gas fission products which might be removed direct from the reactor core and piped past the target material.

The separation of long-lived fission products was discussed by P. E. Carter (Amersham) by reference to the chemical processes and plant used for separation of several curies per year of strontium-90 and cæsium-137. The description of this plant, which may serve as a prototype for large-scale separation of these fission products, illustrated some of the problems which will be met in preparing large sources of high specific activity.

In discussing the value of these different types of fission-product source, it was emphasized that efficient utilization of the radiation requires these materials to be used continuously as they are produced and at all stages of their decay. The removal of short-lived fission products during operation of the reactor would involve modifications to the design of the latter but might lead to improved performance, since some of the fission products are nuclear 'poisons'. The time during which fuel rods could be used as gamma sources might be reduced in future irradiation and 'cooling' schedules; but the use of fuel enriched in the fissile component would lead to higher specific activities after irradiation and would reduce self-absorption of radiation in the source. Use of the fuel rods or of the waste solutions at the concentration at which they would normally be stored would involve only the construction of suitable irradiation vessels.

There seemed no doubt of the technical feasibility of producing sources of megacurie activity which would be required for most large-scale uses of fission-product radiation; but it was emphasized that the initial capital cost would be very great. The present chemical-separation plant is designed to treat fission products as an objectionable by-product; modifications to enable their radiation energy to be used would be more costly than incorporation of these requirements in new plant. The cost of plant for handling active materials is, in any event, greater than that of ordinary chemical plant, not only because of the protection problems involved but also because of the difficulty of maintenance. This imposes severe restrictions on the methods and materials used for what are normally quite simple operations. The cost of concentrating waste solutions beyond the level at which they would normally be stored and the cost of separating individual fission products will be considerable and must be shared between the atomic energy project and the user of the source in accordance with the advantages derived by each.

The second session of the symposium, with Dr. W. Wild (Harwell) as chairman, was devoted to consideration of the uses of fission-product radiation in the chemical, pharmaceutical and food industries. M. W. Perrin (Wellcome Foundation, Ltd.), in a paper on the technical feasibility of the use of fission products, said that many of the radiation sources will be available only at the reactor sites or at the site of the chemical separation plant. This may

contribute to the general re-location of industry both within Great Britain and between countries, this being, in any event, a likely consequence of the development of nuclear power. It is not yet known what radiation chemical reactions are likely to be of value in the industrial field, and the main need at present is for an extended survey of the chemical effects of radiation. It would greatly assist industrial research laboratories in studying systems of special commercial interest to them if they could draw upon men who had been taught the basic facts of radiation chemistry in the course of their university career. As an example of work of special commercial interest, L. Seed (Alkali Division, Imperial Chemical Industries, Ltd.) described some experiments in which an increase in rate of polymerization of ethylene was observed in the presence of gamma radiation from cobalt. Even with a source of only ½ curie, the presence of a gamma-induced reaction could be detected by subtracting the value for the 'thermal' reaction.

Dr. J. W. Barrett, B. L. Budd, Dr. R. Roberts and Dr. D. S. P. Roebuck (Monsanto Chemicals, Ltd.) presented a paper on the economic feasibility of the use of fission products, which showed how the economics of a medium-sized chemical plant are worked out and the influence upon these figures of the cost of radiation sources. Until more technical data are available on radiation chemical reactions, yields and rates, it will not be possible to assess the economic advantages of using radiation. A profitable radiation-induced reaction should be sought among those processes for which capital expenditure and process costs are more important than the cost of raw materials.

In a paper on the preservation of food, Dr. R. S. Hannan (Low Temperature Research Station, Cambridge) summarized the present position of research into the use of ionizing radiations for sterilizing food. It has been established that doses of the order of 2×10^6 r. are necessary, and efforts are now being directed to eliminate the deleterious taste and odour which often result from this method of sterilization. The full techniques finally developed may prove too complex for economic application, except for very special products; but if the process does prove practicable on a wider range of common foodstuffs, many megacurie sources will eventually be required.

W. Jones (Imperial Chemical (Pharmaceuticals), Ltd.) read a paper on the sterilization of pharmaceutical products, which compared present methods of attaining sterility with what is known about the use of radiation for this purpose. While there is a place in the industry for an improved sterilization process, most large manufacturers are already equipped to operate older methods, and a suitable process for small manufacturers must be of low initial cost and economic in use. The advantages of using fission-product radiation—low maintenance cost and ability to sterilize the product in its final container—may ultimately prevail, but much more work is still required.

The last two papers in this session dealt with the effect of ionizing radiation on the physical properties and molecular structure of pre-formed plastics and of synthetic and natural high polymers. Speaking on high-energy radiation and long-chain polymers, Dr. A. Charlesby (Harwell) dealt with the physical changes in such substances as polythene, rubber, polystyrene and 'Perspex' subjected to pile radiation. The observed effects were interpreted in terms of cross-linking between polymer chains and other structural changes. Dr. K. Little (Harwell), in a paper on the effects of ionizing radiation on organic high polymers, attributed the observed changes to many chemical effects, of which cross-linking is only one. Experimental evidence for these conclusions was derived from examination of many fibres ('Orlon', nylon, silk, viscose, etc.) which had been irradiated in the pile.

In the course of the discussion it became clear that there is not sufficient information in either the technical or economic sphere to assess the potentialities of using fission-product radiation in the chemical industry. University research departments could help a great deal by building up a systematic chemistry of radiation effects. The economic assessment awaits more realistic estimates of the cost of producing sources of high specific activity. The type of source required, the site at which it is to be used, the design of irradiation vessel and many other factors are all dependent on the processes to be worked. Guidance on these points is needed at an early stage if full advantage is to be taken of the radiation energy as soon as it becomes available.

Technical feasibility in the preservation of food and sterilization of pharmaceutical products is less in doubt, and some idea of the required doses is already available. With materials for human consumption, however, many very important safety aspects arise. Most of the gamma-rays from fission products are of too low an energy to give appreciable activity through the neutrons produced by (γ,n) processes; but this aspect must be checked, especially for the short-lived fission products. It must also be established beyond reasonable doubt that toxic compounds, including carcinogens, are not produced in irradiated material and that consumption of that material on a large scale and over long periods will have no harmful effects. These are formidable obstacles; but the potential value of the method is great.

In regard to the medical aspects of the subject, it was emphasized that the handling and utilization of megacurie sources would be intrinsically very dangerous, and an important part of the energy and cost of development of the new methods must be applied to these protection problems.

The third session dealt with separated fission products, for many of which important uses have already been found, and this session was therefore less speculative in nature than the earlier ones. Prof. W. V. Mayneord (Royal Cancer Hospital, London), who presided at this session, outlined some of the medical uses of radiation, pointing out that the overall amounts of material required for these purposes are likely to be very much less than the total production; kilocuries of some isotopes, such as cæsium-137, would, however, be required.

Dr. W. P. Grove (Amersham) described methods of mounting separated fission products safely for industrial and medical use. By forging active oxides or salts into silver or other metals, thin foils or plaques can be obtained in which the beta activity suffers little self-absorption and from which no active contamination is removed by rubbing, boiling in water, or similar treatment.

In a paper on cæsium-137 and its use, W. S. Eastwood (Harwell) pointed out that this isotope has a very long-lived beta-gamma emission which is likely to be valuable in medicine for radiotherapy.

Sources of about 5,000 curies mounted in a 5-cm. cube could be used in place of an X-ray teletherapy unit and, unlike the latter, could not fail at a critical moment. Such cæsium-137 sources would also be ideal for use by industry in research and development on radiation chemistry. Dr. J. W. Arrol (Harwell) described the handling and uses of some other fission products. Iodine-131 is used extensively in medicine, and the plant for its large-scale production from fission products was described. The rare gas, krypton-85, is particularly valuable because of its chemical inertness and its radioactive long life. The fact that it is almost a pure beta-emitter makes it possible to handle very high activity sources with little shielding. Its use as a static eliminator, in ventilation control, and for sterilization of blood plasma was suggested.

As a result of this symposium it became clear that the following steps should be taken if the full and efficient use of the radiation from fission products is to be ensured in Great Britain. The assistance of university research departments should be enlisted in an effort to build up gradually a systematic chemistry of radiation effects, particularly in mixtures of organic substances. Industrial research laboratories should be encouraged to use the sources now becoming available to carry out short-term studies of radiation effects which may be of special interest to them. The technical problems of preventing unpleasant taste and odour and of ensuring safety of the product clearly require further attention in the field of food preservation and pharmaceutical sterilization. Realistic estimates of the cost of making available large fission-product sources from existing and from future plant should be prepared. Plans already made for the production of sources of high specific activity from fission-product wastes should be implemented, since this will not only provide sources for medical and industrial use but will also furnish the basic information needed for technical and economic estimates of future large-scale production of sources.

As information becomes available from this work, the overall advantages of using fission-product radiation must be assessed on a national basis and, by close collaboration between the atomic energy project and potential users, a scheme should be worked out for apportioning the additional cost of providing the facilities.

The papers presented at this symposium, together with a full account of the discussion, are being prepared as a Harwell report, and will be on sale at Her Majesty's Stationery Office. The present account is published by permission of the Director of the Atomic Energy Research Establishment.

G. N. Walton
J. Wright

SOLUTIONS OF ELECTROLYTES IN ORGANIC SOLVENTS

A SYMPOSIUM on "Solutions of Electrolytes in Organic Solvents" was held at Buckland House, Buckland, Berks, on April 15 by invitation of the Physical Chemistry Group of the Atomic Energy Research Establishment, Harwell. About fifty people attended, including visitors from various universities and institutions in the United Kingdom and overseas. The meeting was under the chairmanship of Dr. E. Glueckauf (Harwell), who, in his opening remarks, said that the nine papers to be discussed were grouped into three sections: solvent extraction and the nature of addition complexes; acid-base phenomena in non-aqueous solutions; and the constitution of solutions containing iodine.

The first paper, by T. V. Healy and Dr. G. M. Waind (Harwell), was on "The Extraction of Metal Nitrates into Phosphate Esters". Mr. Healy discussed the differences in the extraction of cobalt, sodium, and uranyl nitrates from aqueous solutions by tributyl phosphate, and also partition data for uranyl nitrate between water and the solvents dibutylphenyl phosphate, diphenylbutyl phosphate and triphenyl phosphate. He showed that the thermodynamic equilibrium constants and free energies of transfer of uranyl nitrate between the various solvents are in the order expected from the electron-donor properties of the solvents. Deviations from ideality above 0·1 M were used for estimating approximate solvation numbers for the complexes (for example, $n = 2$ for $UO_2(NO_3)_2.n(BuO)_3PO$). More accurate values were obtained from partition data (with organic concentrations $< 0{\cdot}1\ M$) in the presence of inert diluents, in conjunction with solvent activities obtained from vapour-pressure measurements.

Dr. H. M. Feder (Argonne National Laboratory, Chicago), in a paper entitled "The Stability of Molecular Addition Compounds: a Solubility Technique", dealt with the formation of compounds between mercuric chloride and various alcohols and carbonyl compounds in carbon tetrachloride. Although equilibrium was reached more slowly in organic media than in aqueous solutions, the results were reproducible, and enthalpy, free energy and entropy changes for the reactions were evaluated with good precision. After discussing the applicability and limitations of the solubility technique, Dr. Feder presented results on uranyl nitrate dihydrate with a wide variety of organic bases (donors). Formation constants thus obtained were compared in terms of the general Lewis acid – base theory, as modified by steric requirements.

The discussion on these two papers was opened by Prof. W. F. K. Wynne-Jones (Newcastle upon Tyne), who criticized the use of the term 'base strength' when applied to Lewis donor species. He pointed out that the term can be precisely and usefully defined in the conventional way in aqueous systems, and showed that an attempt to generalize this to obtain a sequence of base strengths valid for all systems merely results in a confused state where a unique order is not even defined within the one solvent. This was supported by Prof. J. A. A. Ketelaar (Amsterdam). In answer to R. P. Bell (Oxford), Mr. Healy said that the water content and electrical conductivity of sodium nitrate solutions in phosphate esters have not yet been determined.

In the session before luncheon, two papers were read from the Atomic Energy Research Establishment, Harwell. H. A. C. McKay, who spoke on "The Partition of Nitric Acid between Water and Ethers", considered first the binary water – ether systems. The differential heats of mixing indicate compound formation, and the water-vapour pressure curve in the water – pentaether system indicates interaction between the dissolved water molecules in the pentaether. In polyethers, the oxygen atoms appear to act independently of each other when forming complexes with water or uranyl nitrate. Mr. McKay said that conductivity and viscosity measurements show that, in most cases, the nitric acid may be considered as

un-ionized in the ether phase, so far as partition results are concerned. The amount of water accompanying the nitric acid into the organic phase varies considerably from ether to ether. The paper concluded with a discussion of the plots of nitric acid activity against the mole ratio of nitric acid to ether, which are strictly linear only at the lowest concentrations.

Dr. Glueckauf's paper on "The Ternary System Nitric Acid – Water – *n*-Butyl Ether" was a thermodynamic analysis based on partition experiments (activities), phase composition data, and molal heat contents obtained by Miss B. L. Ford (Harwell). The four characteristic features of the system are: complex formation, with hydrogen bonding, of butyl ether and nitric acid in 1 : 1 ratio ($-\Delta H = 7$ kcal./mole); association of this complex with water; partial formation of a bimolecular species

$$(Bu_2O.HNO_3)_2.xH_2O \ (x < 1),$$

as indicated by the trend of activities; absorption of nitric acid as a species in which the 1 : 1 ratio is exceeded, in those solutions where the mole ratio of nitric acid to ether approaches unity. This species has a much higher heat content ($\Delta H \simeq 3$ kcal./mole nitric acid) than the normal 1 : 1 complex, and the trends of activities and heat contents are consistent with bimolecular association. Dr. Glueckauf said that these four types of interaction are typical of the ternary systems of all ethers in equilibrium with aqueous nitric acid solutions.

In the discussion, Prof. Wynne-Jones directed attention to the difficulty of obtaining precise formulæ for the addition complexes from purely thermodynamic arguments, and Dr. Feder suggested that, with so many simultaneous equilibria, progress in the detailed understanding of such a ternary system by this method might be rather slow. Mr. Bell and Prof. Ketelaar alluded to the possibility of identifying the complexes postulated by ultra-violet absorption spectroscopy. Dr. Glueckauf replied that two-phase equilibration, using solutions of known activity, permits observations over a greater range than can be attained by almost any other method, and he recommended its wider application, preferably in combination with other techniques.

The first speaker in the afternoon was Prof. Wynne-Jones, who contributed a paper on "The Interaction of Acids and Bases in Non-Aqueous Solvents". After a brief historical survey which stressed the influence of hydrogen bonding in reducing the degree of ionization in non-aqueous systems, he pointed out that such bonding may result in both a displacement of the absorption bands and also a marked entropy change. This was illustrated by results on the interaction between a number of amines and nitrophenols in benzene solutions. By measuring the absorption for different acid/base ratios at a series of temperatures, full thermodynamic data were obtained for the equilibria. The strikingly large entropy effects (~ 30 cal. deg.$^{-1}$ mole^{-1}) were explained by assuming that the benzene molecules are powerfully oriented by the strongly polar compounds. Prof. Wynne-Jones related these results to the mechanism of the Menschutkin reaction and concluded by observing that, in such solvents, the concepts of acid and base tend to lose their sharpness of definition.

Dr. D. D. Eley (Bristol) then presented a paper on "Solutions of Aluminium Halides" which discussed recent results obtained in collaboration with Dr. P. J. King (Bristol). Whereas aluminium bromide gives an ideal solution of Al_2Br_6 molecules in benzene, addition of hydrogen bromide results in the formation of two liquid phases. The upper phase has a low electrical conductivity; but the lower phase, of composition $Al_2Br_6.HBr.6C_6H_6$, is highly ionized. Before addition of hydrogen bromide, the solution has an absorption band at 2785 A. due to $Al_2Br_6.nC_6H_6$; this may be attributed to a charge-transfer spectrum. The introduction of hydrogen bromide suppresses this band, and a new absorption appears at 3300 A. which eventually spreads to 5500 A. at high concentrations. Dr. Eley said that an increase in the pressure of hydrogen bromide, while effecting relatively little variation in the composition of the individual phases, caused the lower to grow at the expense of the upper.

There was a lively discussion of both these papers. Prof. R. S. Mulliken (Chicago), Dr. F. Fairbrother (Manchester) and Dr. N. N. Greenwood (Harwell) spoke of the possible structure of the molecular addition compounds and of the relation of Dr. Eley's results to those in systems containing aluminium chloride and boron trifluoride. Dr. A. R. Mathieson (Nottingham) reported some observations on the effect of aluminium chloride on the spectrum of benzene in *n*-hexane solution: whereas the benzene bands between 2400 and 2650 A. are unaffected, aluminium chloride enhances the absorption below 2400 A. This absorption does not obey Beer's law and suggests formation of a complex. Dr. Mathieson also pointed out that the single peak at 2820 A., obtained for a solution of aluminium chloride in pure benzene, is similar to that observed for a solution of aluminium bromide in the same solvent.

The last group of papers dealt with solutions containing iodine. Dr. L. I. Katzin (Argonne National Laboratory, Chicago) spoke on "Solvation Effects in the Tri-iodide Equilibrium". He first considered the general effects of dielectric constant, donor strength, and stoichiometry on solvation, and then discussed some results obtained with aqueous *t*-butyl alcohol solutions of *t*-butylammonium iodide or sodium iodide, in the presence of iodine. The tri-iodide dissociation constants were obtained by a spectrophotometric dilution technique, using the absorption peak at 3550 A. This gave, independently, both the dissociation constant and the extinction coefficient. Dr. Katzin showed that the shape of the curves of optical density against water content for sodium tri-iodide can be ascribed to a cation hydration effect which is largely complete at low water concentrations. The significance of these results for theories on the constitution of iodine solutions was outlined.

Prof. Ketelaar followed with a paper on "The Colour and Constitution of Iodine Solutions". He pointed out that specific solvation of iodine in solvents such as the chlorinated olefins, though well established, is yet so weak as to leave unaffected the visible absorption spectrum. In the ultra-violet, however, absorption due to the complexes formed is observed. Prof. Ketelaar said that, in a group of related compounds, there is a linear correlation between both the free energy and heat of formation, on one hand, and the frequency of absorption and ionization potential of the donor, on the other. Using benzene as an example, he calculated the difference in bonding energy between the two configurations of the resonance-complex, and showed that this decreases with increasing methyl substitution.

Dr. Greenwood presented the final paper of the symposium, dealing with "The Electrical Conductivity and Colour of Iodine Solutions". Experiments were

described which correlated the colour, conductivity and chemical reactivity of solutions containing iodine, bromine, iodine monochloride or iodine monobromide. He showed that, whereas all violet solutions of iodine are non-conducting, brown solutions conduct ionically by virtue of the equilibrium :

$$\text{solvent} + 2I_2 \rightleftharpoons \text{solvent } I^+ + I_3^-.$$

When a donor solvent is added to a violet solution, it turns brown with simultaneous onset of conductivity. Again, the effect of heat, in tending to alter brown solutions reversibly to violet, is paralleled by a decrease in conductivity which increases again on cooling. Dr. Greenwood pointed out that ionic reactions typical of either the iodine cation or the tri-iodide anion occur rapidly in brown solutions but not in violet solutions, and that there are important similarities between the ultra-violet spectra of brown solutions and the spectrum of the tri-iodide ion.

Prof. Mulliken opened the discussion of these papers by considering in detail the nature of the iodine complexes and their relation to charge-transfer spectra. The structure of the tri-iodide ion was also discussed. Mr. Bell described experiments designed to measure the concentration of positive iodine in strongly acid solutions, and contributions were also made by Dr. Fairbrother and Prof. Wynne-Jones on the significance of dipole measurements in solutions containing iodine and the use of spectrophotometric techniques to obtain equilibrium constants in solution.

The symposium concluded with a short summary of the day's proceedings by Prof. Wynne-Jones. Informal discussions were continued after dinner and provided a fitting sequel to a pleasant day at Buckland House.

N. N. GREENWOOD

SOUTH-WESTERN NATURALISTS' UNION

CONFERENCE AT ILFRACOMBE

THE South-Western Naturalists' Union held its twenty-sixth annual Whitsuntide Conference at Ilfracombe during May 22–25, at the invitation of the Ilfracombe Field Club. The meeting opened with a reception on May 22, when the chairman of the Ilfracombe Urban District Council, Mr. H. P. Smith, welcomed the members ; afterwards, Mr. E. Gill showed a series of films illustrating marine and terrestrial life.

On May 23, the general annual meeting of the Union was held, the chair being taken by the president of the Union, Mr. Mervyn G. Palmer. In his report the honorary secretary, Dr. Stanley Smith, stated at the present time the Union embraces twenty natural history societies, one institution and one private member ; since the last general meeting, held at Plymouth on June 2, 1952, the Salisbury and District Naturalists' Field Club has become affiliated. He announced that three of the affiliated societies, together with a fourth body, have acquired the tenancy of Steep Holm in order to preserve its natural amenities and to make these available to naturalists. Particulars concerning the conditions under which permission to visit the island are granted can be obtained from Mr. J. H. Savory, 61 Lower Redland Road, Bristol 6. Dr. Smith also directed the attention of the Union to the lamentable destruction of the Long Barrow near Marlborough, Wiltshire. A resolution was passed expressing the Union's concern at the loss of these ancient monuments. A letter from the secretary of the Bristol Naturalists' Society, Mr. C. S. Carlile, inviting the Union to hold its next conference at Bristol was read, and this invitation was unanimously accepted.

The election of officers for 1954 concluded the proceedings. Mr. E. R. Harris (Plymouth) was elected president ; and the honorary secretary, Dr. Stanley Smith, the honorary treasurer, Mr. H. W. Turner, and the honorary auditor, Dr. F. S. Wallis, were asked to remain in office. Mr. C. S. Carlile and Mr. R. W. Hall were added to the Council.

In the afternoon, members visited Arlington Court, which for many generations had been the home of the Chichester family and is now the property of the National Trust. In the evening, a lecture on "High Lights and Shadows of Bird Photography" was given by Mr. E. H. Ware.

A comprehensive tour of north-west Devonshire occupied the whole of May 24. On the outward journey St. Nectan's Church, Stoke, was visited and the contorted strata at Hartland Quay were examined. At Hartland Abbey the party was met by Major Stuckley, the owner, and was conducted by him over the house, which is of considerable architectural interest and contains many treasures. On the property is one of the few remaining breeding grounds of the large blue butterfly (*Maculinea arion* (Linn.)). Major Stuckley explained that the area has been fenced around, in an endeavour to preserve the insect, the remarkable life-history of which he briefly outlined. Members were shown over Clovelly Dykes (earth-works attributed by Lady Fox to Iron Age *B*) by Mr. J. C. and Mrs. Hilton. Mr. Hilton also showed flint arrow-heads and other stone implements found in the neighbourhood. He explained that the flint-working site was within a quarter of a mile of the Dykes.

There was a short excursion on the morning of May 25 to Chapel Wood Bird Sanctuary, Spreacombe, owned by the Royal Society for the Protection of Birds and under the administration of the Ilfracombe Field Club.

NATIONALIZED INDUSTRIES IN GREAT BRITAIN

RELATIONS WITH THE PUBLIC

THE Acton Society Trust has published a number of studies surveying certain aspects of the nationalized industries that appear to be specially important, and the last of these studies, No. 12, deals with the relations which are being developed between the nationalized industries*. It is a subject of crucial importance, and, although some parts of it have been discussed in earlier studies, this brief account of the arrangements so far made to foster relations with the public bears closely on the three main topics to which the previous studies have been devoted. A satisfactory solution of this problem would go far to resolve that of the accountability of the industries to Parliament or of their internal industrial relations, and might even contribute substantially to remove some of the difficulties noted in the distribution of authority and the supply of those qualified to wield authority.

* Acton Society Trust. Nationalized Industry Series 12 : Relations with the Public. Pp. 39. (From the Trust, 39 Welbeck Street, London, W.1. 1953.) 2*s*.

The first impression derived from this study is that of the confusion which arises from lack of clear thinking and the failure to reconcile in practice the different interests which nationalization was intended to serve. Next it is clear that some aspects of the conduct of these vast industries go unstudied and unnoticed, and it is possible that much of what the public really thinks and wants is overlooked. A public relations service is clearly essential, and the question is what form it should take.

The study points out that success in this field depends above all on the attitude of the Boards: if their members are insensitive to the problem, the public relations officers can do little, nor has any agreement been reached within the industries on the functions of a public relations department. Few public relations officers appear to have a clear conception of the limits of their obligations, and the Trust suggests that the position of such departments in the nationalized industries requires review in terms both of the functions assigned to them and of the qualifications of their staffs. Moreover, the role of Parliament in this field is limited, and, although the present handicap on its effectiveness may diminish with time, the present system of parliamentary accountability has a strong decentralizing influence which so far the system of consumer councils has failed to counteract. While there is scope for detailed inquiries by universities, research institutions and other interested bodies, which could keep the public in close touch with the performance of the industries, such independent inquiries would have to be conducted on a systematic and intensive basis.

The Trust concludes from this study that the nationalized industries need to give far more attention to this problem, and, in particular, to take a much wider view of their responsibilities than the duties imposed by the nationalizing Acts. They need to find out far more than they already know about the consumer and his views, and the Trust cites the listener research of the British Broadcasting Corporation as an example of what might be done, possibly in co-operation with the consumer councils. No gentler hint that some industries—the study disclaims any inclusive validity for its conclusions—need to become more mindful of the idea of public service could well be given, but the main emphasis is on the flow of information in both directions—from, as well as to, the Boards. The final conclusion, however, is the most urgent: the centre of interest in the relations of the industries with the public needs shifting away from the top. The spur of public scrutiny must be applied at all points, for without ultimate control by Parliament domination by the sectional interests, already so much in evidence, may well follow; but for the individual consumer the basis of public relations is local. The industries should turn their attention to this in an attempt to overcome the feeling of remoteness which many of the public undoubtedly feel and which, as Mr. L. Hardern pointed out last year in his contribution on this theme to "Problems of Nationalised Industry", provides "all the elements of a growing opposition or hostility to the whole of the nationalised industries, irrespective of the success or efficiency they may achieve in their tasks". Apart from quoting that passage from Mr. Hardern's paper, the Acton Society Trust makes little reference to this factor of public confidence and goodwill or to the handicap which the growth of suspicion and misunderstanding could prove to the nationalized industries. Mr. Hardern's paper makes the more useful complement to that of the Acton Society Trust because it includes constructive suggestions for improving the public relations service so as to promote mutual respect and co-operation in the continuous improvement of efficiency and standards of service and morale.

ECONOMIC POSITION OF CAMEROON WOMEN

A RESEARCH grant from the Colonial Social Science Research Council enabled Dr. Phyllis M. Kaberry to study the economic position of women in the Bamenda division of the British Cameroons during the years 1944 and 1948, and she is to be congratulated on having published some of the results of her researches so expeditiously and in such detail*. This 220-page paper-backed report (which is rather high in price) gives a very clear account of the role of women in this very pleasant and atypical region of West Africa—a high grassy plateau, well watered and fertile with as yet no problems of erosion or over-population; it is a region which, through no fault of its own, was split between the British and French mandated areas after the First World War.

The serious part of this report is, no doubt, contained in the chapters on standards of living and on Kumbaw budgets, eighteen of which are given in full in an appendix; but the average reader will probably prefer the more general chapters on the way these people live, and on the things in life which they value. In Bamenda they consider that it is the man's job to rule and to provide the very modest cash income of the household, and it is the woman's to grow the food and to feed the family.

The Nigerian Government, to judge from Prof. C. D. Forde's preface to the report, considers the status of women in Bamenda to be unduly low and to constitute one of the contributory causes of the under-population of the region as well as a social obstacle to its economic development. Dr. Kaberry's report leaves one with the impression that this status, even if it might be considered low by comparison with urban Yoruba and with certain Ibo and Ibibio groups in the eastern region of Nigeria, is certainly not a contributory cause of under-population. If a comparison could have been made with other parts of the Cameroons or even with some of the adjacent 'pagan' provinces of the northern region, quite different opinions might have been formed. It is, after all, only by a political accident that the British Cameroons has become a province of the eastern region, a region which differs completely from Bamenda ecologically, economically and culturally. As for being an obstacle to development, this surely depends primarily on how the women are approached. Any plans for economic development, as Dr. Kaberry says, must take into account the fact that women will continue to assume the major responsibility for agriculture; the immediate problem, therefore, is to improve their techniques and their organization of labour. The present policy of demonstration plots and "instruction in needlework and hygiene" is unlikely to make much impression upon them.

G. I. Jones

* Women of the Grassfields: a Study of the Economic Position of Women in Bamenda, British Cameroons. (Colonial Research Publication No. 14.) By Dr. Phyllis M. Kaberry. Pp. 220+11 plates. (London: H.M.S.O., 1952.) 32*s.* 6*d.*

EFFECTS OF SALTS ON INTERACTIONS IN POLYELECTROLYTE SOLUTIONS

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In recent years a number of investigations has been made in capillary tube viscometers of the viscosity of aqueous solutions of polyelectrolytes and the effect of added salts thereon. The effects have been interpreted in terms of the theory of polyelectrolyte molecules by Arnold and Overbeek[1], and by Fuoss[2]. According to this theory, the effect of salts is to cause a coiling of the polyelectrolyte chain owing to a decrease of the repulsive forces of its charges.

In the case of deoxyribonucleate solutions, similar effects might be expected *a priori*. A large decrease of the viscosity is brought about by salts at moderate concentrations (10^{-3}–10^{-4} gm./ml.), but at extremely small concentrations an entirely different type of behaviour has been observed. Pouyet[3] found in a study of the viscosity of such solutions in the Couette viscometer that the reduced viscosity (η_c/c) decreases rapidly with diminishing concentrations in the region between $c = 10^{-4}$ and 10^{-5} gm./ml., and in the limit $c \to 0$ approaches the same limiting value as the (constant) value which it has in salt solutions. This type of behaviour has been confirmed by us[4] with several samples of deoxyribonucleic acid, which differ somewhat in the concentration at which the decrease of viscosity begins. Also, very small concentrations of salts (10^{-3}–10^{-4} M) have a marked effect on the viscosity at concentrations above those which possess the limiting value[4].

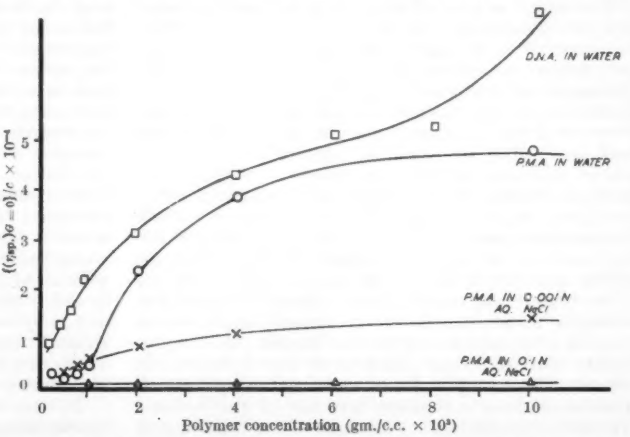
A falling off of the reduced viscosity of polymers at very small concentrations was observed by Boyer and Streeter[5] and by Moore and Russell[6], who attributed it in part to adsorption from the very dilute solutions on the surfaces of the viscometer. This does not seem to be a significant factor in our experiments, as the solution was poured out of the viscometer and replaced until a constant value of the viscosity was obtained. A maximum of the specific viscosity of polymethacrylate solutions at $c = 0{\cdot}05$ per cent was observed by Alexander and Hitch[7].

It therefore seemed to be interesting to determine the effect of salts on specific viscosities of solutions of a typical polyelectrolyte, at smaller concentrations than any yet recorded and at very low shear rates, to see if a similar type of behaviour occurs. We have made such measurements in the Couette apparatus with a highly polymerized polymethacrylic acid of molecular weight $2{\cdot}2 \times 10^6$ (used as 60 per cent sodium salt) kindly given us by Dr. P. Alexander, and the results are given in the accompanying graph. As can be seen, the behaviour is very similar to that of deoxyribonucleic acid. However, it has been difficult to reach sufficiently low concentrations to establish with certainty whether the intrinsic viscosity of this material reaches the same value in water as in salt solutions; but there is no doubt that the effect of salts (in the limit of zero shear), which is very great at moderate concentrations, is greatly diminished at concentrations of the order of 10^{-5} gm./ml.

At concentrations below those where the rapid fall of η_c/c occurs, namely, 0·003–0·001 per cent, it is noticeable that the plot of η_c/c is again nearly horizontal. This may indicate that a region is now being approached where the particles are moving independently and intermolecular interaction is no longer significant. This behaviour between 0·001 and 0·00025 per cent also confirms that adsorption effects are not vitiating the results.

The interpretation of these facts would be difficult except on the same basis as already suggested in the case of solutions of deoxyribonucleic acid, namely: (1) that increase of reduced viscosity with concentration is due to increasing interaction of the particles, and (2) the extent of the interaction at a given concentration is greatly reduced by even a small concentration of salts. Hence, the interaction of the polyelectrolyte particles must be regarded as a general feature in all but the most dilute solutions; and the effect of salts on the viscosity should not be ascribed solely to changes of extension of the particle. Incidentally, it might be noted that the reduction of viscosity by 0·1 N sodium chloride on 10^{-4} gm./ml. polymethacrylate is of the order of 99·5 per cent. On the basis of the present measurements, it is impossible to exclude a relatively small effect of the salt on the intrinsic viscosity (*c.* 50 per cent), so that some change of shape of the isolated particle may occur in the presence of salts. But it would be difficult to explain the increase of the reduced viscosity with concentration, except on the basis of interaction.

If this view is correct, we may inquire into the origin of interactions of polyelectrolyte particles which occur at low concentrations and are greatly reduced by even small concentrations of salts. It has been suggested[7] that hydrogen bonding occurs and is responsible for the abnormal dependence on shear in such solutions; but it is difficult to see how hydrogen bonds could be sensitive to small amounts of salt. We find it difficult to avoid the conclusion that the interaction must be electrical in nature and due to interionic forces between the polyions and their



Reduced viscosities $\eta_{sp.}/c$ of dilute solutions of: (1) deoxyribonucleic acid (DNA) in water; (2) polymethacrylate (PMA) in water and salt solutions

counter ions. The counter ions may, in fact, attempt to complete their ionic atmospheres by attracting more than one polyion, and this will give rise to attractive forces between the polyions—an effect which would be greatly diminished by added salts. An effect of this nature was proposed by Staudinger[8] in his 'swarm' theory, but it has been held that the facts support a 'shape' theory better[9]. Also Overbeek and Verwey[10] have found theoretically that the double layers of two (large) charged particles tend to repel each other. The interaction of charged rod-like particles has also been studied by Dube[11], whose calculations suggest that an attractive force between particles may occur under certain conditions. It could be argued that the decrease of interaction produced by salts is a consequence of a change of shape or configuration, but this does not agree with the comparatively small effect of salt at small concentrations of polyelectrolyte and does not explain the nature of the interaction. A more extensive study of a variety of systems will be required before this can be confidently decided. The facts given above provide a new outlook on the problem and suggest that a considerable degree of electrical interaction arising from the interionic forces between polyions and their counter ions may be a common feature of such solutions, and that the abnormal dependence on shear of the viscosity of these solutions may be a consequence of such electrical interactions. The degree of interaction between two particles will vary continuously and will depend on their distance from a common ion. On this view, all degrees of interaction may be expected to occur and the shearing forces will themselves affect the amount of interaction since they will pull apart particles in which the electrical attraction holding them together is less than the force produced by the shear. A more detailed study of such effects is being made and will be published elsewhere.

We wish to thank Dr. P. Alexander for specimens of polymethacrylate. This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anne Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [April 7.

Note added in proof (July 1). It is necessary to mention two possible alternative explanations of the effect observed. (1) At high dilutions hydrolysis of the polyelectrolyte salt might occur, resulting in a displacement of the equilibrium $NaP + H_2O \rightleftharpoons HP +$ NaOH to the right, so that at high dilutions a greater fraction of the polymer is present in the less viscous acid form. The ratio NaP/HP should depend on the pH of the solution, but measurements of this made in dilute solution show no significant change. (2) Since solutions exposed to air contain dissolved carbon dioxide, the reaction $H_2CO_3 + NaP = NaHCO_3 + HP$ will occur to a significant extent at high dilutions of the polymer, since the pK's of the two acids are of a similar magnitude. It is difficult to make the viscosity measurements in the Couette apparatus in the complete absence of carbon dioxide, but experiments with solutions which were free from carbon dioxide when prepared and measured as quickly as possible showed a marked decrease of the reduced viscosity on dilution. Although there was a slow decrease of these values with time on exposure to air, the initial values obtained should refer to carbon dioxide-free solutions. The observed decrease of viscosity on dilution therefore appears not to be due to the reactions mentioned.

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STATISTICAL SIGNIFICANCE IN PSYCHICAL RESEARCH

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IT is proposed to show that the logical form of the data derived from experiments in psychical research which depend upon statistical tests is such as to provide little evidence for telepathy, clairvoyance, precognition, psychokinesis, etc., but to give some grounds for questioning the practical validity of the test of significance used.

The recent aim of research workers setting out to demonstrate the occurrence of telepathy, etc., has been to devise experiments to give statistically significant results which might reasonably be interpreted as evidence for the phenomena claimed. They have succeeded in doing this, but with important limitations. In the first place, although some of the experimental results appear by statistical reasoning 'highly significant', identical experimental conditions do not as a rule bring about their repetition. Thus, in an important sense, the phenomena remain undemonstrated.

The other serious limitation in the so-called demonstrations of telepathy, etc., is the lack of satisfactory control series. This is because control series in this work cannot be relied upon to give results which are any the less curious and 'significant' than those of the main series. The classic example is Coover's[1] experiment in card guessing, where half the cards to be guessed by the subjects were known to the experimenter at the time of guessing, and the other half—the control series—were not known to anyone until afterwards. Coover found no appreciable difference between the results of the main series and those of the control, and rightly concluded that he had found no evidence for telepathy. It has since been pointed out[2] that both Coover's main series and his control show a deviation of successful guesses above the mean expectation. If all the trials are pooled, the calculated probability of obtaining so large a deviation in either direction by chance alone is less than 0·005, which by convention is quite significant. The experimental result has been therefore reinterpreted in terms of a new phenomenon, clairvoyance, which the experiment was not designed to show.

In later experiments, more unexpected 'significant' deviations appeared in what should have been chance results, and new labels were used for explaining them. For example, correspondences between lists of

guesses and packs of cards shuffled and scored after the guesses had been made were referred to as 'precognition'. (This expression was also used, with less justification, for describing a simple displacement of hits.) Later still, correspondences between the faces falling uppermost on a die and certain arbitrarily (or randomly) chosen 'target faces' were taken as evidence that an experimenter could influence the fall of the die merely by thinking about it; this was called 'psychokinesis'.

For reasons I shall make clear below, the claim to have demonstrated psychokinesis is theoretically of more interest than the claims to have demonstrated telepathy and the other phenomena. However, it should be pointed out that the results of the 'psychokinesis' experiments are generally indistinguishable from those of experiments in telepathy, etc. The decline in scoring within the temporal unit[3] ('beginners' luck' curve) is equally prominent; the findings, however 'significant', are not susceptible to demonstrable repetition[4]; and control series tend to be as curious as the main series[5]. But here, unlike the case of Coover's experiment, experimenters have not been able to explain the curious results of their 'psychokinesis' controls in terms of any new phenomenon, and have had to fall back upon explanations in terms of more psychokinesis: such 'explanations' therefore beg the question at issue.

A test of statistical significance depends upon the randomization of the set of observations. As Fisher[6] points out, this is "the physical basis of the validity of the test". It must therefore be assumed for experimental purposes that the means of randomizing, such as shuffling cards, throwing dice or refinements of these methods, will not appear to be influenced at all by what the experimenter is thinking about. If we may not assume this, then we have no empirical reason for considering the test to be valid. But psychical research workers now claim to show that in many cases the experimenter does appear to influence the means of randomizing merely by thinking about them: yet in appraising their results these workers depend solely on a test of significance which is valid only if the results they claim do not in fact occur.

This is a curious state of affairs. It is clear that, by the very logic of the situation, no mere statistical test of significance can suffice to demonstrate the existence of a causal relationship between the falls of dice and the thoughts of their observers, simply because to apply the test in such a case is to assume a contradiction. Equally, if 'significant' results are obtained in a well-designed and properly observed 'psychokinesis' experiment, then all the statistical 'demonstrations' of telepathy, etc., must now be called into question, since they, like the dice experiments, rely on statistical significance only, and not upon demonstrable repetition or comparison with controls. The claim for psychokinesis has thus made nonsense of these claims for telepathy, etc., besides being itself, on the evidence, a nonsensical claim.

Since it is clearly meaningless to speak of 'influencing' random-producing agents on evidence which is nothing more than statistically significant, and since there nevertheless exist a number of highly 'significant' results in the best designed and most rigorously observed experiments, the simplest explanation left open to us is that the calculus which leads us to interpret these results as significant is itself misleading. The only purpose of devising criteria of statistical significance is to provide a guide to indicate what observations we make will be repeatable; that is, the concept of *statistical* significance is useful only as a guide to *inductive* significance. But statistical significance in psychical research is clearly not a guide to inductive significance; it is therefore incumbent upon us to try the hypothesis that the results of the best-designed and most rigorously observed experiments in psychical research are chance results after all, and that the concept of chance can cover a wider natural field than we previously suspected.

This hypothesis is equivalent to the assumption that random series do not in fact 'behave' quite as we have hitherto assumed they do. If this is true, then it should be noticeable in fields where randomizing processes have been used for other purposes than psychical research. In later papers I hope to show that the present criterion of statistical significance appears to have been systematically misleading in certain zoological experiments in much the same way as it appears to have been in psychical research. In addition I have evidence, also to be published shortly, that statistically significant results similar to those of psychical research are obtainable simply by making selections in published tables of random numbers as if the tables were themselves the data of a psychical research experiment. This procedure, which consists in matching randomly selected columns of random digits and scoring successes as they are scored in columns of recorded cards and guesses, produced, in the first experiment, results which differed from the mean expectation by more than three standard deviations; and these results, together with later ones, are indistinguishable from those produced by orthodox psychical research. The deviations are not as large as have been found in some experiments in telepathy, etc.; but what is chiefly interesting is that such results should be 'significant' at all, and that the degree of 'significance' should in fact be as high as it is.

There are some who might suggest, following Keynes[7], that all these results cannot show anything other than that the randomizing processes used were not of the best quality, thereby implying that if we had used better randomizing agents, results of this kind would not appear. However, by now such a wide variety of randomizing processes have been claimed as objects of successful 'psychokinesis' experiments, all giving results of a characteristic form, that it would be surprising suddenly to find one which was in this respect different from all the others; and if we are finally reduced to saying that all the random series we can produce are imperfect in this way, it is equivalent to saying that there is something wrong with our concept of randomness as a model for describing what we actually observe. This possibility, which Keynes ignored (though Venn[8], writing much earlier, did not), is one which accumulated evidence is now forcing us to consider. There is, however, another reason why this possibility is worthy of consideration.

The concept of physical randomness upon which applied probability theory depends is necessarily vague in much the same way as the concept of physical simultaneity is vague. Attempts to remove the vagueness in the case of the randomness concept by using it only for series of infinite length do not touch the empirical problem since they leave us with no practical means of ever completing a test for randomness. As a result, the criterion for a random series is extremely arbitrary, being merely that there

is no *obvious* formula for its construction; and what is obvious, of course, varies between observers. Perhaps it should therefore be a matter of some surprise that present probability theory applied to science in fact works as well as it does; and if we could discover how it is that it does work so well, we might be able to see how it is that it does not appear to work quite well enough.

I wish to express my gratitude to the Perrott Electors of Trinity College, Cambridge, under whom the new description of this psychical research problem was originally made, and to Prof. A. C. Hardy, of Oxford, who generously provided a grant for the research to continue in his Department. I should also like to thank Sir Ronald Fisher, by whose writings and conversation I have been greatly helped.

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EVIDENCE FOR 2-CHAIN HELIX IN CRYSTALLINE STRUCTURE OF SODIUM DEOXYRIBONUCLEATE

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WATSON AND CRICK[1] have proposed a structure for sodium deoxyribonucleate consisting of two co-axial helical chains related by a diad axis. We have shown[2] that the main features of their structure are consistent with certain important features of our X-ray diagrams of structure *B* (the high-humidity less-ordered form of the salt). A subsequent closer investigation of density and water content in relation to the prominent equatorial spacing, and also of equatorial intensities calculated from a projection of the proposed structure (kindly provided by Watson and Crick), makes it clear that in detail the structure is not consistent with the observed equatorial reflexions. Both density and intensity considerations lead us to favour a more compact helical structure in which the phosphorus atoms lie on a helix of radius about 8·5 A. rather than 10 A. This value also lies within the range of spread of the more diffuse layer-line peaks.

We are more concerned here, however, with evidence which confirms in principle the type of structure suggested by Watson and Crick, than with criticism on points of detail.

If a 2-chain helical molecule exists in structure *B*, then such a molecule, in modified form, must also exist in structure *A* (the crystalline form obtained at 75 per cent relative humidity), since the change $A \rightleftharpoons B$ is readily reversible. The purpose of this communication is to point to evidence for a 2-chain helical molecule in structure *A*.

For structure *A* we have measured the positions and intensities of reflexions and have calculated the cylindrically averaged Patterson function[3]. The work

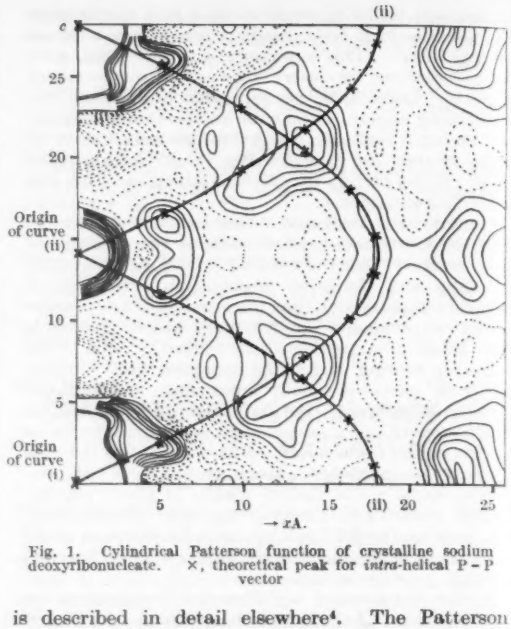

Fig. 1. Cylindrical Patterson function of crystalline sodium deoxyribonucleate. ×, theoretical peak for *intra*-helical P – P vector

is described in detail elsewhere[4]. The Patterson function is reproduced in Fig. 1. The theoretical curve for the Patterson function of a smooth helix of radius 9·0 A. is also shown (curve (i)). The very strong peak at height $z = \frac{1}{2}$ on the fibre axis suggests that the phosphate groups of the two chains are separated by approximately $\frac{1}{2}c$. We therefore added to Fig. 1 curve (ii), which completes the theoretical Patterson function for two smooth co-axial helices separated by $\frac{1}{2}c$ (*c* is the pitch of the helix). Curves (i) and (ii) together clearly pass through a large proportion of the important Patterson peaks. Moreover, if we take into account the fact that the real structure contains, not smooth helices, but phosphate groups equally spaced along such helices, the agreement is even better.

The only near-meridional reflexion in the X-ray diagram of structure *A* is a rather weak one on the eleventh layer-line. This suggests that there are eleven nucleotides per turn of the helix. (This is sufficiently near to the number ten, found for structure *B*[1,2,5], for the reversible transformation $A \rightleftharpoons B$ to be plausible.) Further, we may suppose that the well-resolved peak at 5·7 A. from the pseudo-origin peak at $z = \frac{1}{2}$ represents a P – P vector, and this distance is exactly that between neighbouring phosphorus atoms if eleven are equally spaced along one turn of a helix of radius 9 A. In Fig. 1 we have marked with a cross the theoretical positions of intra-molecular Patterson peaks to be expected for this arrangement, assuming that the phosphorus atoms on one helix lie vertically above those on the other. The agreement with the observed Patterson peaks is seen to be remarkably good.

In Fig. 2 we have marked on the Patterson function the positions of all inter-molecular P – P vectors obtained when, in the unit cell described below, there is one molecule (that is, two chains) associated with each lattice point. The circles in Fig. 2 have each only 1/11 of the weight of the crosses in Fig. 1, and 1/22 and 1/44 of the weight of the pseudo-lattice points (relating phosphate residues only) shown by crosses

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near the half-cell height in Fig. 2. The lattice points relating the whole structure are denoted by larger crosses near to the origin level in *c*. In addition to this weighting, for correlation with the cylindrically averaged Patterson function, the weight of each calculated peak should be considered as inversely proportional to x, since in averaging it must be spread over a circle of radius x. When these factors are taken into account, it will be seen that agreement between calculated and observed Patterson peaks is still good.

Space group, density and the unit cell. Using the cylindrical Patterson function, we have been able to identify the lattice vectors (indicated in Fig. 2) and hence to index all 66 observed reflexions. The unit cell is face-centred monoclinic having $a = 22{\cdot}0$ A.; $b = 39{\cdot}8$ A.; $c = 28{\cdot}1$ A.; $\beta = 96\frac{1}{2}°$. If the unit cell is truly monoclinic, the space-group can only be *C*2, since the molecule contains asymmetric carbon atoms. Again, since the structure of the phosphate sugar backbone chain is non-centric, the symmetry axis cannot pass through such a chain, but must relate the chains one to another in pairs. There must, therefore, be an even number of chains associated with each lattice point.

In order to calculate the number of nucleotides in the unit cell, it is necessary to know both the density and the water content. Unfortunately, these quantities can only be measured on a polycrystalline mass, and there must remain some uncertainty as to the true density and water content of the crystallites. Our measurements[5] gave a density of 1·47 gm./c.c. at 75 per cent relative humidity and a water content of about 40 per cent of the dry weight (or about $8H_2O$ per nucleotide). We have confirmed that the specimens used for these measurements were in the form of structure *A* and not structure *B*. These results correspond to twenty-three nucleotides per lattice point, which is in reasonable agreement with the suggestion that the primitive unit cell contains eleven nucleotides on each of two chains.

The three-dimensional Patterson function. After establishing the unit cell and indexing the reflexions, the complete three-dimensional Patterson function

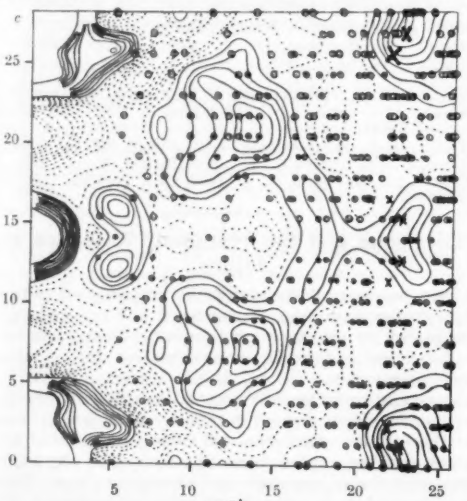

Fig. 2. Cylindrical Patterson function of crystalline sodium deoxyribonucleate. ○, theoretical peak for *inter*-helical P – P vector

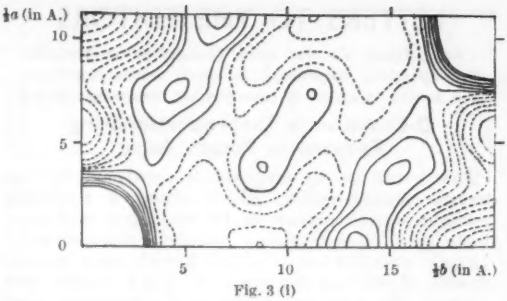

Fig. 3 (i)

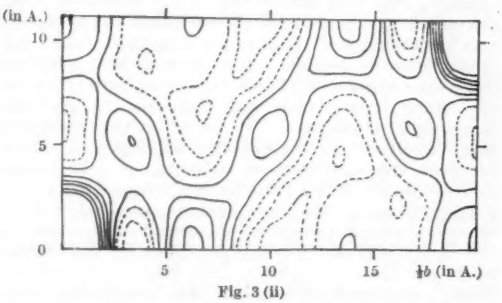

Fig. 3 (ii)

Three-dimensional Patterson function of crystalline sodium deoxyribonucleate. Sections in $a - b$ plane at (i) $z = 0$, (ii) $c = \frac{1}{2}$

was calculated. This will be published and discussed in detail elsewhere. The $a - b$ sections at heights $c = 0$ and $c = \frac{1}{2}$ are shown in Fig. 3. The very strong peak at $a = b = 0$, $c = \frac{1}{2}$ suggests a pseudo-halving of the unit cell. On the other hand, all features of the zero section other than the origin peak are almost entirely reversed in the section $c = \frac{1}{2}$. This at once suggests that only a part of the structure repeats at $c = \frac{1}{2}$. This is exactly what would occur for two co-axial chains related by a diad axis, as suggested by Watson and Crick. The phosphate groups repeat at $c = \frac{1}{2}$, as indicated in Fig. 1; but, since the two chains run in opposite directions, this will not be true of the rest of the molecule.

Relationship between structure A and structure B. In conclusion, we suggest that the unit in structure *A* is, as in structure *B*, two co-axial helical chains running in opposite directions. In the change from *B* to *A* the number of residues per turn increases from ten to eleven and the pitch of the helix decreases from 34 A. to 28 A. In structure *A* the phosphate groups lie on a helix of radius 9 A., with a separation of approximately $\frac{1}{11}c$ between the phosphate groups of the two co-axial chains.

The vertical component of the inter-base distance is thus decreased from 3·4 A. in structure *B* to 2·55 A. in structure *A*. This indicates that in structure *A* the planes of the bases cannot be perpendicular to the fibre axis. The positions of the strong reflexions on the sixth, seventh and eighth layer-lines suggest that the angle of tilt is about 25°.

We are grateful to Prof. J. T. Randall for his interest and encouragement. One of us (R. E. F.) acknowledges the award of a Turner and Newall Fellowship. [June 25.

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LETTERS TO THE EDITORS

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D-Enzyme: a Disproportionating Enzyme in Potato Juice

The synthesis of amylose is catalysed by the enzyme phosphorylase, which effects a reversible transglucosylation reaction between glucose-1-phosphate and chains of α-1 : 4-linked glucose units. Hitherto this has been the only known plant enzyme capable of effecting the synthesis of α-1 : 4-glucosidic linkages. We now have to report the discovery of an enzyme in the potato which can effect the synthesis and degradation of (short) amylose-type chains by transglucosylic action. The enzyme was detected in greatest amount in the alcohol-precipitated fraction of potato juice which also contains the greatest amounts of *Q*-enzyme. The latter enzyme catalyses the conversion of amylose into amylopectin, which involves the simultaneous splitting of α-1 : 4-links and synthesis of α-1 : 6-links (an irreversible transglycosylation)[1]. The new enzyme manifested itself when a *Q*-enzyme preparation was allowed to act on the linear maltosaccharides produced by the partial acid hydrolysis of amylose[2]. Two effects were noticed. First, iodine-staining material was synthesized from the achroic saccharides and, secondly, paper chromatograms of the digests revealed that the substrates had been disproportionated into products of higher and lower molecular weight, the latter including glucose. For this reason, we have provisionally named the new factor *D*-enzyme.

D-enzyme brings about rapid disproportionation of malto-triose, -tetraose, -pentaose, -hexaose and -heptaose ; but action in the case of maltose is doubtful. Glucose itself is not a substrate. The greater the molecular weight of the maltosaccharide substrate, the greater is the final intensity of iodine stain. With maltohexaose the iodine colour changes through brown and red to purple-red, the intensity then remaining very nearly constant for prolonged periods of digestion. On addition of glucose to such a digest, however, the iodine-staining power disappears rapidly. The simplest explanation of these results would be that the action of *D*-enzyme is to effect the transfer of glucose units, either singly or severally, from one molecule of substrate (donor) to an acceptor molecule, which may be either a maltosaccharide or glucose. Furthermore, in view of the fact that the products stain with iodine, it would seem probable that the linkage synthesized is of the α-1 : 4-chain-forming type.

Proof of the unbranched character of the products was obtained by treatment of maltotetraose with *D*-enzyme and afterwards with salivary α-amylase. Charcoal fractionation of the hydrolysate yielded only glucose, maltose and maltotriose, and in amounts corresponding to 97 per cent of the maltotetraose taken. This result demonstrates that *D*-treated maltotetraose does not contain any substantial proportion of branched structures. Thus waxy maize starch, in which α-1 : 6- and α-1 : 4-links are present in a ratio of 1 : 23, is hydrolysed by α-amylase to yield maltose (41·8 per cent), maltotriose (28·4 per cent) and 29·8 per cent of limit dextrins containing both types of linkage[3].

While it is clear that *D*-enzyme catalyses redistribution reactions among linear maltosaccharides, the pattern of its action is still obscure. The most significant observation concerns the place of maltose in this scheme. As already mentioned, *D*-enzyme appears not to utilize maltose as a substrate and, moreover, maltose is not formed (except in traces and only after prolonged action) when *D*-enzyme acts on other maltosaccharides. Thus the lower molecular weight products from each maltosaccharide always contain in addition to glucose every lower linear maltosaccharide except maltose. Possible explanations of these effects are being considered, but further work is obviously necessary and is proceeding.

It seems evident that the role of glucose in causing removal of iodine-staining material (see above) is due to its functioning as an acceptor for the transferring action ; it cannot act as a donor. In a parallel experiment, *D*-enzyme was allowed to act on maltohexaose, and glucose labelled with carbon-14 was then added. When the digest became achroic the products were fractionated on paper. Radioactivity was found to be distributed throughout the zones corresponding to the maltosaccharides.

Two bacterial enzymes are known which catalyse somewhat similar reactions. Amylomaltase from *E. coli*, which synthesizes amylose-like molecules from maltose[4], is clearly different from *D*-enzyme. The Schardinger dextrinase action reported by Norberg and French[5] does, however, bear a certain resemblance to that of *D*-enzyme. The *in vivo* function of *D*-enzyme can, at the moment, be a matter for conjecture only ; but it may either provide 'primers' for phosphorylase synthetic action, or itself catalyse the synthesis of amylose. The latter possibility carries with it the implication that phosphorylase function may be confined to the degradation of starch.

We are grateful to the Agricultural Research Council for financial assistance, and wish also to thank Dr. Helen Porter for the gift of carbon-14 starch and Dr. L. H. May for measurement of the radioactivity.

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Cortisone and the Metabolic Response to Injury

The pattern of the metabolic response of man to injury (for example, fracture of a long bone), in particular its effect on protein catabolism, has been under investigation for some time by one of us[1] as this phenomenon is of basic importance to our understanding of protein metabolism in general. The reaction is characterized in man by a marked increase in the urinary excretion of nitrogen and sulphur, which reaches a peak from the fourth to the eighth day after the injury and then slowly declines. There is also a loss of phosphorus and potassium. This phenomenon has been confirmed by many workers and in other forms of injury[2]. Cuthbertson, McGirr

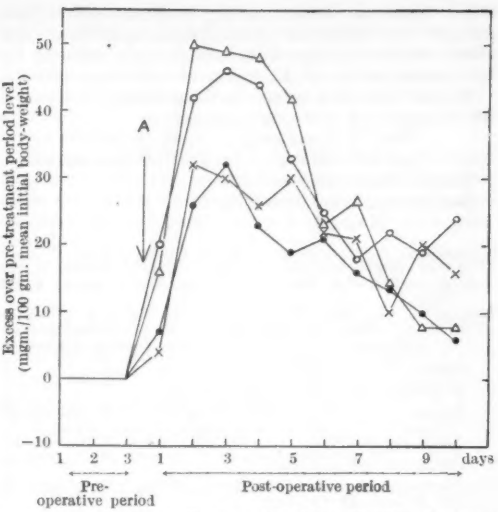
and Robertson[3] have also found the same thing to occur in the rat, though rather earlier. The losses appear to be more general than local in origin.

In 1942, Albright[4] first suggested the view that the catabolic impulse of the alarm reaction of Selye may be due to an excessive production by the adrenal cortex of '*S*-hormone' (now identified as the gluco-corticoids), simultaneously with a decreased production of '*N*-hormone' (now identified as adrenal testoids). In 1947, Ingle, Ward and Kuizenga[5] found that the negative nitrogen balance, which characteristically develops following fractures, seems to require the presence of adrenal cortical hormones, but is not caused specifically by an increase in the secretion of the cortical hormones during stress. Selye[6] has suggested that here we are dealing with a peripheral synergism between the corticoids and other factors produced by stress. Kochakian and Robertson[7] have shown that in the mouse this metabolic effect of cortisone can be divided into at least two sharply defined phases: a rapid mobilization of readily available protein stores, followed by a period of metabolic readjustment or adaptation, the striking feature of the first phase being the rapid decrease in body-weight and extra nitrogen excretion, and this seems to be concomitant with a maximum involution of the lymphatic tissues. While the mobilization of protein from lymphoid tissue is considered by these authors to be a specific property of the gluco-corticoids, it seems doubtful if the lymphatic tissue is adequate unless it is larger than we surmise. Ingle[8] has also reported a protein catabolic phase in rats receiving cortisone which disappeared after about ten days. Eliel *et al.*[9] have pointed out that patients in whom hyperadrenocorticism occurred spontaneously or was induced by administration of adreno-corticotrophic hormone or cortisone exhibited losses of nitrogen, potassium and phosphorus strikingly resembling those of operative trauma, a similarity already pointed out by one of us.

As the period of increased protein catabolism which follows an injury such as a fracture in the rat[3] seems to have much in common with the results of implanting cortisone, it seemed appropriate to determine if the protein catabolic effects of injury and cortisone administration in the rat were similar in their general character and what would happen if they were superimposed. For this purpose the males of several litters of Rowett Institute stock rats at approximately three months old and around 300 gm. body-weight were divided into four treatment groups, a decision based on earlier trials. These groups were: (1) subcutaneous implantation of 25 mgm. cortisone acetate; (2) fracture of femur by open operation through incision comparable to that required for fracture; (3) subcutaneous implantation of 50 mgm. cortisone acetate; (4) fracture + implantation of 25 mgm. cortisone acetate subcutaneously. The implantations and fracture were all done under ether anæsthesia. Sham-operated controls showed little disturbance of nitrogen metabolism, a finding in keeping with earlier observations.

The animals were maintained for some time before treatment and continuously thereafter on a constant stock food intake.

It will be seen from the graph and the table that in the rat the effects of implanting subcutaneously one 25-mgm. tablet of cortisone acetate and of fracture of a femur are similar in character and magnitude as measured by change in urinary nitrogen. On superimposing upon the implantation of one 25-mgm.



×—×—, Cortisone, 25 mgm. (6 rats); ●—●—, fracture (6 rats); O—O—, cortisone, 50 gm. (6 rats); △—△—, fracture + cortisone, 25 mgm. (5 rats). *A*, arrow indicates cortisone (25 or 50 mgm.), fracture, or fracture + cortisone (25 mgm.)

pellet either a simultaneous fracture or a second 25-mgm. pellet through the same incision, the net effects are again very similar, and greater than that of fracture or of one pellet separately, although not so great as if they were additive. S.E. of difference between the mean of the first two treatments on one hand and that of the other two is ± 30 (13 d.f.).

The evidence thus suggests strongly that the effect of fracture of a femur in the rat is roughly equivalent to the effect of slowly liberating 25 mgm. of cortisone (calculated as acetate) from the adrenal cortex, and that increasing the stimulus (as measured by cortisone) increases the response, possibly on a progressively reducing scale. Whether we can go further and say that the effect of such an injury is to cause the liberation of such a quantity of gluco-corticoid from the adrenal cortex is not so certain.

The magnitude of these responses is apparently conditioned by the amount of hormone implanted and by the presence or absence of injury. It seems unlikely that the results with cortisone are exaggerated responses to the injury caused by a plethora of hormone at the act of implantation, as might possibly be deduced from the observations of Engel[10]. The similarity in response of two pellets of cortisone to one pellet plus fracture and the almost identical separate effects of one pellet and fracture render this very doubtful.

It is difficult to account for these findings in the light of the observations of Ingle *et al.*[5] to which reference has already been made, unless it is presumed that the effect of injury is not to evoke a liberation of hormone from the adrenal cortex but to cause

Increase of Urinary Nitrogen Value over Basal for 10 Days Following Treatment

	Cortisone acetate (25 mgm.)	Fracture	Cortisone acetate (50 mgm.)	Cortisone + fracture acetate (25 mgm.)
Increase in mgm. nitrogen per 100 gm. body-weight	196	202	297	269

some change in the circulating hormone which then induces the catabolic phenomenon, and that this effect can be replicated by the changes induced by the implantation of 25 mgm. of cortisone acetate.

We are indebted to the Medical Research Council for a supply of 'Cortone' (Merck).

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Reversal of the Antibacterial Activity of Polymyxin by Divalent Cations

The antibiotic polymyxin has been used with some success in the treatment of *Pseudomonas æruginosa* infections of burns[1]. Previous studies have shown that the addition of polymyxin to washed suspensions of this organism caused a release of pentose, phosphate and materials which had an absorption maxima at 260 mμ[2,3]. The leakage was a maximum in the presence of concentrations of polymyxin which killed 99 per cent of the cells, higher concentrations inhibiting the leakage.

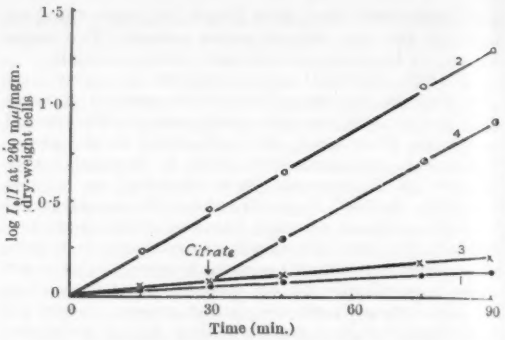
When washed cells were treated with polymyxin in the presence of magnesium, it was found that the leakage of soluble constituents from the cells did not occur (see graph). This 'protective' action of magnesium could be reversed by the addition of 2 molecules of citrate per atom of magnesium present.

Growth experiments using a complete growth medium (tryptic digest of casein which contained the equivalent of 3 per cent (w/v) casein) showed that the limiting inhibitory concentration of polymyxin could be increased by as much as thirty times by the addition of magnesium (Table 1). However, in these experiments the effective concentration of magnesium could not easily be determined, as there was some precipitation with the constituents of the medium.

Table 1. Increase in the Limiting Inhibitory Concentration of Polymyxin in the Presence of Magnesium

An inoculum of *c.* 10^8 cells/10 ml. was used. + indicates visible growth after incubation for 24 hr. at 30°

	Concentration of polymyxin (μgm./ml.)									
Magnesium conc.	0	0·25	0·5	1	2	4	8	16	32	64
0	+	+	+	+						
0·0125 *M*	+	+	+	+	+					
0·025 *M*	+	+	+	+	+	+	+			
0·05 *M*	+	+	+	+	+	+	+	+	+	



Curve 1, leakage of materials with an absorption maximum at 260 mμ from washed cells of *Ps. æruginosa* suspended in 1 per cent (w/v) sodium chloride solution. Cell density 1 mgm. dry weight of cells per ml. Temperature 30°.

Curve 2, same as (1) + 25 μgm. polymyxin/ml.

Curve 3, same as (2) + magnesium sulphate to give a final concentration of 0·0025 *M*.

Curve 4, same as (3) + sodium citrate (final concentration 0·005 *M*) after 30 min.

When suspensions of washed cells (containing about 2×10^9 viable cells/ml.) were treated with 15 μgm. polymyxin/ml. for 5 min. at 30°, less than 10 per cent of the cells remained viable. In the presence of *M*/400 magnesium, 70–90 per cent of the cells were viable. Similar results have been obtained with other non-toxic divalent cations; for example, calcium, manganese and ferrous iron (Table 2). The results of preliminary experiments have indicated that the presence of such cations prevents the absorption of polymyxin by the cells.

Table 2. Reversal of the Antibacterial Activity of Polymyxin by Divalent Cations

Washed cell suspensions (*c.* 2×10^9 viable cells/ml.) treated with polymyxin (15 μgm./ml.) at 30° in the presence or absence of the cations shown below. After 5 min., 1 ml. samples were withdrawn and transferred to 99 ml. sterile saline. Suitable dilutions were plated out in growth-medium containing 2 per cent agar, and the colonies counted after incubation for 48 hr. at 30°. All figures are the mean of four experiments

Treatment of cell suspensions	Plate count	Dilution factor	Survivors (per cent)
Untreated	262	10^7	—
+ 15 μgm. polymyxin/ml.	166	10^6	6
+ 15 μgm. polymyxin/ml. + 0·0025 *M* Mg^{++}	216	10^7	83
+ 15 μgm. polymyxin/ml. + 0·0025 *M* Mn^{++}	184	10^7	71
+ 15 μgm. polymyxin/ml. + 0·0025 *M* Ca^{++}	236	10^7	90
+ 15 μgm. polymyxin/ml. + 0·0025 *M* Mg^{++} + 0·005 *M* citrate	188	10^6	7

There seem to be two possible explanations of the above results: (1) competitive absorption between polymyxin and the non-toxic cations for sites on or in the cells; (2) formation of a polymyxin – metal ion complex with the resultant inactivation of the antibiotic. In view of the high magnesium/polymyxin ratio (*c.* 400 atoms magnesium per molecule of polymyxin) required to reverse the antibacterial activity, the former hypothesis would seem to be more reasonable.

Valko and DuBois[4] reported the protective action of relatively harmless cations against the action of

toxic, surface-active cations, and suggested that the basis for the antibacterial action of such cations could be satisfactorily described in terms of cationic exchange.

Bliss, Chandler and Schoenbach[5] found that polymyxin was inactivated by soap, lipositol and other substances known to antagonize cationic detergents. The results reported above, together with those of Newton[2,3] and Few and Schulman[6], further support the resemblance between cationic detergents and polymyxin, although cationic detergents are generally far more effective against Gram-positive than Gram-negative organisms, whereas polymyxin is more active against the latter.

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A Colorimetric Estimation of Sugars using Benzidine

A solution of benzidine in acetic acid has been used by Horrocks and Manning[1] as a chromatographic spray reagent for the detection of sugars. A quantitative technique, using this reagent, has been perfected and found to be satisfactory for the majority of common sugars (cf. McCance[2]) and their methylated derivatives with the exception of ketoses. Concentrations as low as 0·1 mgm./ml. were estimated, with errors of less than 3 per cent.

The procedure for estimation was as follows. 1 ml. of sugar solution and 5 ml. of 0·2 per cent (w/v) benzidine in glacial acetic acid were placed in a boiling-tube and heated in a vigorously boiling water-bath. The heating time necessary for maximum colour production varied with the nature of sugar being estimated (see table). After cooling to room temperature in running water, the orange-yellow coloration was measured with a Hilger Spekker (Ilford No. 601 filter). The relationship between concentration and absorption was linear for the following sugars:

Sugar	Heating time (min.)
Glucose	30
Mannose	"
Galactose	"
Glucuronic acid	"
Galacturonic acid	"
Rhamnose	"
Arabinose	15
Ribose	"
Xylose	"
2 : 3 : 4-Trimethyl xylose	60
2 : 3 : 6-Trimethyl glucose	"
2 : 4 : 6-Trimethyl glucose	"
2 : 3 : 4 : 6-Tetramethyl glucose	"
Sucrose	"
Maltose	"
Raffinose	"

Polysaccharides have been analysed by the new method, quantitative separation of the monosaccharide components being effected by paper partition chromatography. Sugars were extracted from the paper with hot 90 per cent methyl alcohol, and the methanolic sugar solution evaporated down to a syrup *in vacuo*. The required volume of distilled water was then added, and a 1-ml. aliquot of the solution taken for analysis. Standard sugar mixtures separated by the above procedure were estimated with errors of 3–5 per cent.

The mechanism of the reaction has been examined and it appears that molecular equivalents of benzidine and sugar (having a free or easily accessible aldehyde group) combine to give a coloured compound.

The mild nature of the reagents used, and the wide range of sugars which can be estimated, are the two main advantages of the new method.

A detailed report of experimental method, results, and applications will be published elsewhere.

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Isolation and Biochemical Function of the Golgi Substance

Recent studies have demonstrated the positive image of the Golgi substance in epithelial cells of the mouse epididymis with the phase-contrast microscope[1]. *In situ*, the Golgi substance was found to possess characteristic optical properties with phase-contrast and dark-field illumination, and to be completely refractory to staining with methylene blue and neutral red. Examination of cells of the head of the epididymis of the rat and the mouse immediately after or during crushing clearly indicated that the Golgi substance retained its general form and its specific optical properties upon release from its intracellular environment. Experiments to determine the most suitable medium for the maintenance of the Golgi substance extracellularly indicated that the presence of 0·34 *M* sodium chloride was essential and that the addition of sucrose in concentrations ranging from 0·25 to 1·25 *M* to the saline medium had no appreciable effect on the morphology, optical properties or stability of the Golgi substance.

The isolation of the Golgi substance was accomplished by a modification of the method of Brakke[2], which we have used with some success in the fractionation of isolated liver mitochondria[3]. A 20 per cent homogenate of rat epididymis in 0·25 *M* sucrose was prepared[4], layered over a sucrose density-gradient consisting of 1·0-ml. layers of 0·335, 0·636, 0·957 and 1·11 *M* sucrose, each containing 0·34 *M* sodium chloride, and centrifuged for 60 min. at 35,600 r.p.m. (108,000 *g* average) in the *SW* 39 horizontal rotor of a Spinco Model *E* ultracentrifuge. The Golgi substance was found to sediment in a sharp yellowish band 2–3 mm. wide at the bottom of the 0·636 *M* sucrose layer (Fig. 1); and since clear layers at least 5 mm. wide were present on either side of the Golgi band, it was found possible to separate this band by cutting the centrifuge tube at appropriate points. Microscopic examination of the separated Golgi layer showed that it contained large clumps of bodies with the optical properties under phase- and dark-ground illumination (Fig. 2) characteristic of the Golgi substance as it is seen in the intact cell and extracellularly

Fig. 1. Photograph of tube after centrifuging epididymis homogenate layered over sucrose density-gradient. Note bands of particulate material at regular intervals above sediment. The first band above the sediment consisted of submicroscopic particles, and the second (arrow) contained the Golgi substance. Fat was found at the very top of the tube surmounting a layer of the soluble proteins of the homogenate

in crushed preparations. In addition, some submicroscopic material was also observed in this layer; but the main mass of the submicroscopic particles of the epididymis homogenate sedimented as a sharp band at the bottom of the 0·957 *M* sucrose layer. It is noteworthy that no material resembling free lipid could be identified in the band containing the Golgi substance, nor could any material stainable with neutral red or methylene blue be observed in this layer. Furthermore, Golgi material was not observed in any other parts of the centrifuge tube. Thus it is believed that a relatively complete separation of a sedimentable component or components of the Golgi substance of the rat epididymis has been achieved.

The histochemical observations[5], which indicated a high concentration of alkaline phosphatase in the region of the Golgi substance of the epithelial cells of the intestine, prompted us to study the distribution of this enzymatic activity in the separated epididymal fractions. The results are given in the accompanying table, and show that alkaline phosphatase activity was greatly concentrated in the layer containing the isolated Golgi material, thus apparently confirming the histochemical results.

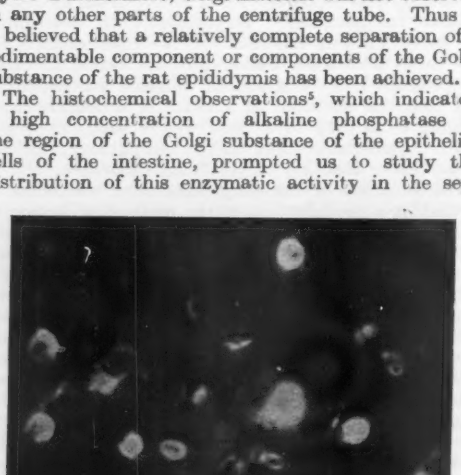

Fig. 2. Photograph of Golgi particles in dark field 2 hr. after isolation in 0·636 *M* sucrose containing 0·34 *M* sodium chloride. The majority of the particles have a refractile, crescent-shaped or horseshoe-shaped periphery with a less refractile centre. × 3,000

Intracellular Distribution of Alkaline Phosphatase Activity and Total Nitrogen in Rat Epididymis

The results are presented in terms of 100 mgm. of fresh tissue or its equivalent

Fraction	Composition of fraction	Position in centrifuge tube	Total nitrogen	Alkaline phosphatase activity*	
				Total	Per mgm. nitrogen
Whole homogenate			1·68	101·5	60
1	Fat-soluble material	Upper	0·916	69·5	76
2	Golgi bodies, some submicroscopic particles	Middle	0·091	43	473
3	Submicroscopic particle layer mitochondria nuclei, sperm	Lower	0·795	37	46·5

* Expressed as micrograms phosphorus released in 15 min. at 37° C. from sodium glycerophosphate at *p*H 9·4.

Further studies on the chemical composition and enzymatic constitution of the Golgi substance are in progress and will be reported in detail elsewhere.

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Occurrence of Cholinesterase in *Tenebrio* and *Tribolium*

Lord and Potter have reported[1] that they could not obtain preparations of *Tenebrio molitor* larvæ or *Tribolium castaneum* adults which could hydrolyse acetylcholine. This failure is surprising in view of the supposed ubiquity of cholinesterase "in conductive tissue throughout the whole animal kingdom"[2], and is of importance because of its bearing on the question of the mode of action of organophosphorus insecticides. Since both insects are killed by low concentrations of tetraethyl pyrophosphate (TEPP), Lord and Potter's observations would indicate that the significance of its anti-cholinesterase effect is not as great as had been thought[3]. Although the authors stated that "no persistent attempt was made to prepare an extract hydrolysing ACh", their work has been taken to show[4] the absence of cholinesterase in these insects. In their principal preparation, the supernatant from their homogenates was treated with half its volume of ethyl alcohol. The inability of the resultant solution to hydrolyse

acetylcholine is not surprising in view of the anti-cholinesterase activity of ethyl alcohol[5]. Furthermore, the brei was centrifuged at two stages, and the centrifugates rejected; Babers and Pratt[6] have shown that, in the honey-bee, five-sixths of the cholinesterase is in the centrifugate of whole brei.

Experiments are here reported using less drastic treatment. The insects were homogenized in distilled water in a Potter–Elvehjem homogenizer (ice-cooled), and 2·5 ml. (usually) of whole brei were used. The standard Warburg technique was employed, using 1 ml. of buffer (0·31 *M* sodium chloride, 0·67 *M* sodium bicarbonate, 0·0024 *M* potassium chloride, 0·0012 *M* calcium chloride), and tipping in 0·2 ml. acetylcholine bromide (0·022 *M*). An atmosphere of 5 per cent carbon dioxide in nitrogen was used at a temperature of 25° C. The ensuing procedure and analysis of results were as described by Aldridge *et al.*[7]. Determinations in triplicate were made for each brei.

For *Tenebrio*, the b_{30} per larva was 11·1 µl. ± 0·4 (average of three runs) (b_{30} = vol. of carbon dioxide released in 30 min.). This method of expressing the results was used because the number, not the weight, of larvæ was held constant in each run. The grand average live-weight per larva was 191 mgm. In other runs breis were treated with ethyl alcohol to a final concentration of 33⅓ per cent. No evolution of carbon dioxide was detected, an indication that at this concentration cholinesterase is totally inhibited. Tyrosinase is probably inhibited also, since the alcohol-treated breis showed no darkening. The study of breis inhibited with tetraethyl pyrophosphate is difficult by this method because the hydrolysis of the pyrophosphate causes the evolution of carbon dioxide from sodium bicarbonate. In the only attempt made to use tetraethyl pyrophosphate (at 10^{-3} *M*), however, the rate of evolution of carbon dioxide was unaltered when the acetylcholine was tipped in. The inhibition of all cholinesterases by tetraethyl pyrophosphate was considered too well documented to justify further study.

Using *Tribolium* adults, the b_{30} per gm. live-weight was 132 µl. ± 3·4 (average of three runs). Again ethyl alcohol, 33⅓ per cent final concentration in brei, gave 100 per cent inhibition. Preliminary experiments had shown that for larvæ as well as pupæ of *Tribolium* the b_{30} was of the order of 60 µl. per gm. live-weight.

These experiments demonstrate the presence of cholinesterase in larvæ of *Tenebrio molitor* and adults, pupæ and larvæ of *Tribolium confusum*.

I am indebted to Dr. B. N. Smallman for advice and encouragement.

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Intranuclear Proteins of the Oocytes in *Artemia salina* L.

Recent biochemical and cytological investigations, dealing with the problem of intranuclear proteins, suggest that the nucleus has an important role in protein metabolism. In addition to the nucleoproteins, of both the ribonucleic and deoxyribonucleic types, histones and more complex non-histone proteins have also been described in the nucleus. Chromosomin[1] and the so-called 'residual protein'[2] belong to this last group. But, as earlier suggested by A. L. Dounce[3], it was emphasized by cytological studies of A. W. Pollister and C. Leuchtenberger[4] that the interphase nucleus contains a considerably larger amount of other proteins of non-histone type. Evidence has accumulated that it is mainly these non-histone proteins which differ from cell to cell; this fraction can be important in the general metabolism of the cell.

Young oocytes of *Artemia salina* L. seem to be a favourable material for the cytochemical study of the intranuclear proteins. The nucleoproteins during oogenesis have already been described[5]; a large amount of ribonucleic acid was found in the nucleoli, and strongly Feulgen-positive granules were revealed.

By the use of the Millon reaction, according to the cytochemical technique of A. W. Pollister and collaborators[6,7] (both the trichloracetic and the sulphuric), on material fixed in various liquids, the presence of two different proteins, one of the histone and another more complex, becomes evident. The results are different if the material is fixed in liquids containing acetic acid.

The Millon reaction for total proteins on material fixed in liquids without acetic acid (alcohol–formol (90–10), formol 30 per cent, osmic acid, formol–calcium (Baker, Helly, Gelei) is strongly positive in nucleoplasm and nucleoli. This nucleoplasmic protein is more easily detectable on oocytes fixed in alcohol–formol, formol 30 per cent and osmic acid than in other non-acetic fixatives, because it is homogeneous in the former while granular in the latter. The intensity of the reaction can be little different from one ovary to another and is probably related to the moment of fixation. By highest intensity, the chromatin granules do not stand sharply out against the Millon-positive homogeneous nucleoplasmic protein mass. Just before the great cytoplasmic increase in the oocyte the reaction is strongest; a decrease occurs in the nuclear vesicle. Some ovaries contain a small number of oocytes which are partially or completely lacking in this nucleoplasmic protein. The Millon reaction (sulphuric), after treatment of the sections to detach most of the histone, was also positive.

Animals fixed in liquid containing acetic acid (Carnoy, alcohol – formol – acetic acid (85–10–5), Zenker) have shown the following results: the Millon reaction for total protein is only positive in nucleoli and chromatin granules, while clearly negative in the nucleoplasm; after extraction of the histone, the Millon reaction is practically negative throughout the nucleus, excepting for the chromatin granules, which are lightly positive.

These results with our *Artemia* material seem to prove the presence of a large amount of protein of non-histone type in addition to histone and the nucleoproteins mentioned above. This protein is only present in material fixed without acetic acid. Thus fixation with acetic acid, not only in alcoholic but

also in aqueous medium, involves a loss. Staining reactions demonstrated a strong affinity for acid dyes, like orange *G*.

Both histone and acetic acid-soluble basic protein were present in nucleoli, but only the latter in nucleoplasm, at the stage when the oocyte shows the greatest nucleolar activity as seen by an increase of the basophilia and the number of nucleoli[5]. Thus this non-histone basic protein seems to be the expression of a metabolic activity of the nucleus preparing to function in the synthesis which accompanies growth of the oocyte, as suggested by Pollister[8]. Possibly synthesized in nucleoli, this protein of non-histone type which is soluble in acetic acid should be able to influence the cytoplasmic activity through the nucleoplasm.

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Sterility in *Theobroma cacao* L.

Pound[1], during his 1937–38 expedition to the upper reaches of the Amazon, made a collection of *Theobroma cacao* L. types which he hoped would be resistant to witches broom disease, *Marasmius perniciosus* Stahel. These were sent to Trinidad as material for his breeding programme. In 1943 Posnette[2] visited Trinidad from the Gold Coast and obtained pods from these trees, as he was interested in their possible resistance to cacao swollen shoot virus.

With hand-pollination, Posnette soon found that the trees were all self-sterile but to a limited extent cross-fertile. In their cross-fertility they differed from the cultivated Trinidad population, in which all self-sterile trees are also cross-sterile, depending for successful pollination on self-fertile trees. The self-fertile trees in this Trinidad population cross readily among themselves and with the self-sterile trees[3]. No satisfactory genetic hypothesis has been advanced to explain this system.

The progeny of Posnette's crosses were planted at Tafo in 1945. An extensive programme of cross-pollination on the progeny has enabled us to formulate a genetic hypothesis to explain their sterility. In the types so far tested we have found that five alleles (designated *W1*, *W2*, *W3*, *W4*, *W5*) at a single locus are involved. The alleles differ in potency and follow the sequence $1 > 2 = 3 > 4 > 5$. The diploid constitution of the male and female parent determines the success or failure of the cross. The alleles exhibit dominance according to the above sequence.

In two plants which have a similar sterility mechanism, *Crepis fœtida*[4] and *Parthenium argentatum*[5], dominance is only exhibited in the pollen; the alleles of the style act independently. In these *T. cacao* types the female reaction, in addition to the male, is sporophytic and dominant, and so the reciprocal-cross differences found in *Crepis* and *Parthenium* cannot occur. The system we have found in *T. cacao* resembles the hypothetical one suggested by Bateman[6].

The cacao types differ further from *Crepis* and *Parthenium* in that the stylar tissue is not the site of the incompatibility. Failure occurs at a much later stage, possibly after fertilization of the ovules. Although the system ensures cross-pollination, it is at enormous expense in terms of reproductive material.

A full report of the genetics of sterility in these types and their relation to the system found in the Trinidad population will be published later. The present communication is published by permission of the Director of Cacao Research.

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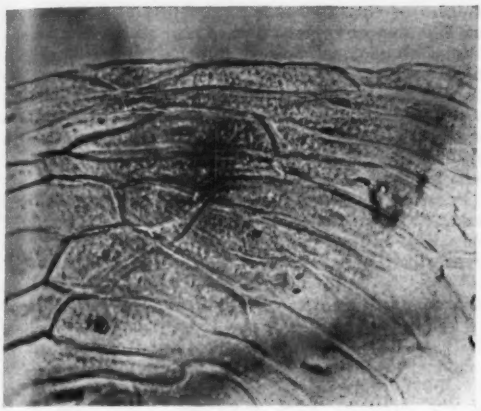
Resistant Components of the Cortex of Animal Hair

The possibility that there exists beneath the scaly layer or cuticle of animal hair another peripheral layer has been discussed both in these columns[1,2] and elsewhere[3,4]. The supposed layer has been named variously subcutis, between-membrane, and cortical mantle. The most convenient way to show that there does exist a resistant non-keratinous residue beneath the cuticle was described by Alexander and Earland[4]. Hair or wool is oxidized with weak aqueous peracetic acid and then extracted with dilute ammonia solution. The oxidation destroys the disulphide cross-links which stabilize the keratin, rendering it soluble in alkali. The non-keratinous residue consists of (*a*) thin tubes each looking like a cast of the cuticle and consisting mainly of the thin membrane, the epicuticle, which envelops the scales externally, and (*b*) a cortical residue, which seen from the side looks like a rather tenuous tube of cortical cells[3]. This latter was thought to be the new morphological component, the subcutis[4].

In order to make sure of the exact disposition of this residue within the cortex, the experiment has been carried out on cross-sections of oxidized hair. On treatment with ammonia, these cross-sections swelled to about three times their original diameter and the cortical residue was seen to extend network-like throughout the cortex and to consist of the cell membranes which originally bounded the cortical cells. There was no sign of a distinct subcuticular membrane. The material used in this work has been mainly human hair and wool fibres; but the accompanying illustration is of a portion of the cross-section



Portion of a cross-section of oxidized whale hair treated with dilute ammonia. This hair has no cuticle. The keratin has dissolved from the cortical cells leaving the cell membranes and minor resistant particles

of whale hair. This interesting hair was chosen for illustration because it has no cuticle and the cortical cells are very well defined right to the edge of the hair[5].

In addition to the cell membranes, various other particulate forms (or short sections of elongated forms) resist solution. Of these, part are found in nuclear cavities (see illustration) and may be derived from nuclear membranes, and the remainder are distributed throughout the cells. In wool fibres the distribution of these latter particles is asymmetrical. They are found predominantly in one half of each fibre cross-section, and this distribution may be related to various other phenomena, such as twisting[6], curling[7], and dyeing, which point to a structural asymmetry in wool fibres.

I wish to thank Mr. John Facq for a gift of whale hair.

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'Slow' and 'Fast' Nerve Fibres in Locusts

Pringle[1] has demonstrated the existence in the cockroach of a functional double-innervation of the extensor tibialis muscle. He describes a single slow and a single fast fibre to this muscle, both the axons running in the metathoracic nerve trunk designated 3*b*. The threshold for excitation of the fast fibre is lower than that of the slow fibre. Single impulses sent down this nerve produce brief twitches in the extensor tibialis. There is incomplete fusion of twitches at 50 impulses per sec. and a smooth tetanus results at frequencies in excess of 70 per sec.

In order to demonstrate the properties of the slow-fibre system, Pringle found it necessary to dry out the whole nerve trunk and then remoisten it with saline carefully. In this way he was able to knock out the fast-fibre system while retaining functional activity in the slow one. Electrical stimulation of the slow fibre then initiates a smooth tonic contraction of the muscle at frequencies of 50 per sec. and above. Electrical records of the muscle potentials produced during slow-fibre stimulation show a marked facilitation. The extent of the facilitation is about six times, taking 0·1 sec. to develop maximal spike height at 185 impulses per sec.

In the locusts *Locusta migratoria migratorioides* R. and F. and *Schistocerca gregaria* Forsk, the probable homologues of Pringle's cockroach nerve 3*b* contain only slow fibres to the extensor tibialis muscles. Stimulation of these nerves gives a smooth tonic contraction which starts at about 10 impulses per sec. The speed of contraction increases with increasing frequency of stimulation and is rapid at 200 impulses per sec. Fast fibres to the same muscles are contained in the large crural nerve trunks, the probable homologues of Pringle's nerve 5 in the cockroach. Single impulses in these nerve fibres give powerful twitches. Smooth tetanus begins at about 30 impulses per sec. In the locusts there is no evidence of electrical facilitation in either the fast or the slow systems. Each nerve stimulation gives an 'all-or-nothing' electrical disturbance in the muscle, as recorded by external electrodes.

This anatomical separation of the two types of nerve supplying the same muscle makes it a simple matter to demonstrate the existence of slow- and fast-fibre systems in an insect. The two types of contraction can be shown in the same animal consecutively by placing stimulating electrodes on the appropriate nerve trunks, and applying suitable electrical pulses to each in turn. Very little dissection is required, and the whole is very suitable for class demonstration and experiment. The preparation renders possible a detailed study of the events associated with neuromuscular transmission in the two systems.

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Heterothallism in *Chætomium*

During the course of an investigation of the fungus flora of seed oats being carried out by Malone[1], evidence was obtained which suggested that *Chætomium elatum* Kunze and Schmidt might be heterothallic in spite of the fact that Marchal and Marchal[2] and Ames[3] had reported fruiting from single ascospore cultures of this species. To investigate this point, eight single ascospore isolations obtained from a perithecium produced on an oat seed were grown on a wide range of media, where they failed to produce fertile perithecia although perithecial primordia were formed abundantly. Fertile perithecia were obtained, however, in some cases when these isolates were plated in pairs in all combinations and the isolates were therefore numbered 1–8 with 1 arbitrarily designated as (+). Of the eight strains, 1, 5

and 6 were (+) and fruiting occurred when these were plated with the (−) strains 2, 3, 4, 7 and 8. A further 114 single ascospore isolations were made and cultured in quadruplicate against the original 1 (+) and 2 (−) strains. Of these, 63 fruited in contact with a (−) strain and 51 with a (+) strain, thus giving totals of 66 (+) and 56 (−) for the 122 isolates used. Control cultures of all isolations produced only perithecial primordia.

Observations showed that the density of perithecial production was not uniform but depended upon the particular strains brought together. The regularity with which this phenomenon occurred when repeated matings with isolates 1–8 were made over a period of time showed it not to be fortuitous, and suggests that the heterothallism exhibited may be effected by a multiple allelomorphic system affecting the quantitative capacity for sexual reproduction.

Chivers[4], in his monograph on the genus, listed twenty-three synonyms under *Chætomium globosum* Kunze. Three forms were isolated from seed oats which fell within his diagnosis for the species. Of these, two were very similar morphologically and differed markedly only in the colour of the perithecia, which was in one case greenish and in the other grey. Both these forms produced fertile perithecia from single ascospore cultures. The third form required the pairing of single ascospore cultures for perithecial production; and of fifteen isolates, seven were found to be of one mating type and eight of the other. This third form closely agreed with *Chætomium olivaceum* Cooke and Ellis[5], which was considered by Chivers[4] to be synonymous with *C. globosum*. The fact that it is heterothallic and has much larger ascospores ($12{\cdot}3\mu \times 9{\cdot}6\mu$, as opposed to $10{\cdot}5\mu \times 8{\cdot}5\mu$ for the green form and $10{\cdot}5\mu \times 8{\cdot}0\mu$ for the grey form) indicates that the synonymy of Chivers cannot be accepted and that the species of Cooke and Ellis should be re-erected. All three forms could be separated physiologically by their differing reactions to different sources of carbon in media employed for this purpose.

This work formed part of an investigation carried out for an honours degree in the Faculty of Agriculture in the Queen's University of Belfast under the direction of Prof. A. E. Muskett, to whom I am indebted for advice and encouragement.

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Spores and Tracheids of Vascular Plants from the Vindhyan System, India: the Advent of Vascular Plants

In a recent paper entitled "Evidence for the Existence of Vascular Land Plants in the Cambrian", by K. Jacob, (Mrs.) Chinna Jacob and R. N. Shrivastava, to be published shortly in *Current Science*, we have recorded a few spores and fragments of tracheids of vascular land plants from authentic samples of the Neobolus Shales of the Salt Range, the Middle and Upper Cambrian of Kashmir and the Cambrian of Spiti. Some of the spores described there are provided with bladders and in others they are absent, the latter in some cases showing body ornamentation. In this preliminary note we have tentatively referred these spores to the Pteridophyta and the Pteridospermæ; it is possible that some may even belong to the primitive Gymnospermæ.

Pursuing these studies further, specimens of the Suket Shales (containing well-preserved specimens of *Fermoria*) belonging to the upper part of the Semri series[1] of the Lower Vindhyans, near Rampura (lat. 24° 28′; long. 75° 26′), Central India (now Madhya Bharat), were treated with hydrofluoric acid followed by Schultze's fluid. The specimens macerated belong to H. C. Jones's original collection[2] from the above locality (Geological Survey of India, Reg. No. K24/997). Several spores and a few fragments of woody elements were recovered. But the spore assemblage is restricted to only five or six types, all of which appear to be comparatively primitive. In one slide as many as twenty spores, with or without tri-radiate mark, were recovered. Winged spores or those with surface ornamentation or furrow were entirely absent.

In view of the prevailing scepticism regarding the advent of vascular plants so early as the Cambrian, all possible precautions were taken against contamination and the results obtained by us were repeatedly checked.

Although A. K. Ghosh and others[3] have reported the occurrence of spores and tracheids in the Cambrian sediments of India, there still persists some doubt regarding their finds. The present communication recording spores obtained from samples of the Suket Shales, together with the results of our examination of Cambrian sediments from the Salt Range, Kashmir and Spiti[3], may, it is hoped, carry conviction that such organic remains, if carefully searched for, will be found to occur in several Cambrian horizons hitherto believed to be devoid of any trace of vascular plants. From the Olive Shales of the Lower Vindhyans in the Mirzapur district, Ghosh and Bose[4] figured four pieces of woody elements and a single small spore. From the Suket Shales we have recovered several more plant remains, including a variety of spores.

In this short communication no attempt is made to describe the individual spores, though it may be stated that those recovered from the Suket Shales have been provisionally grouped into six major types depending on their morphology, and include spores belonging probab'y to the primitive Pteridospermæ and Pteridophyta (? Psilopsida, ? Sphenopsida), and to doubtful primitive Gymnospermæ.

Conclusions. (i) *Advent of land plants.* Ghosh and Bose[4] examined a sample of the Olive Shales (Semri series, Lower Vindhyan), from a locality east of Patwadh, Mirzapur district, Uttar Pradesh, and reported a few fragments of tracheids and several small smooth-walled spherical spores, one of which was figured by them. The spore, which is rather small in size with a short raised ridge or fold on one side, could also possibly be considered to belong to a primitive non-vascular plant. The several spores recovered by us from the Suket Shales (Semri series) belong to at least six different groups of vascular plants, probably representing the Equisetales and other primitive Pteridophyta, the Pteridospermæ

and very doubtful primitive Gymnospermæ, in addition to some non-vascular cryptogams. The additional evidence now obtained by us, along with the earlier reports of traces of vascular plants in the Cambrian of the U.S.S.R.[5], Esthonia[6], eastern Sweden[7] and India[3,8,9], should offer food for thought to those who are not inclined to accept the existence of vascular land plants in pre-Silurian times. In view of the poor preservation of the comparatively few spores recovered, however, these tentative suggestions of affinities should be taken with reserve. Nevertheless, it is fairly safe to suggest that the vascular land plants were in existence even as early as the Lower Cambrian.

(ii) *Age of the Lower Vindhyan.* The occurrence of probable Equisetalean spores recalling those described by Naumova[5] from the Lower Cambrian Pre-Baltic clays, and by Reissinger[6] from sediments of more or less the same age in Esthonia, seems to throw additional light on the age of the Lower Vindhyans. In view of the close similarity of the majority of spores from the Suket Shales with those mentioned above, it is suggested that the Suket Shales occupying the top part of the Lower Vindhyan (and possibly the entire Lower Vindhyan, comprising 1,000–3,000 ft. of sediments) may not be older than the Lower Cambrian in age. It is possible that the Upper Vindhyans may then be Upper Cambrian with the possibility of their extension to the Ordovician. In this connexion, a statement by Pascoe[10] on the age of the Vindhyans is of significance: "An assumption that the Lower Vindhyan represents the lower half of the Cambrian would make the Upper Vindhyan equivalent perhaps to the Upper Cambrian *plus* an unknown portion of the succeeding system or systems. This would admittedly fill a gap in the geological sequence, for there are no other sediments in the Indian Peninsula which could with probability represent any part of that sequence from the Cambrian to the Lower Carboniferous. That such a long period of time should be entirely unrepresented over such an extensive area is, of course, possible, though the odds seem slightly more in favour of some relics of the Palæozoic rivers, estuaries or seas surviving".

It is of further interest to note that the spores recovered by us from the Neobolus Shales and other Cambrian sediments from Kashmir and Spiti[8] show a higher morphological evolution than those from the Suket Shales, probably because the spores from the latter belonged to more primitively organized land plants which flourished in earlier Cambrian times. The Neobolus Shales and the early Palæozoic sediments of Kashmir and Spiti, which yielded the more highly organized spores, are probably of ? Middle and Upper Cambrian age. On the whole, it seems not unreasonable, therefore, to refer the Lower Vindhyans to the Lower Cambrian. However, the evidence at present available is still meagre and the above suggestions on the age of the Vindhyans should be taken with reserve.

The discovery of the remains of vascular land plants from the Vindhyans and other Cambrian sediments in India and elsewhere is of far-reaching significance in stratigraphy and in unravelling the early phylogeny of the vascular plants, on which an entirely new light is now being thrown, necessitating a re-orientation of certain well-established ideas. It is therefore of prime importance to undertake careful and systematic search for the remains of vascular plants in the early Palæozoic and even in the Proterozoic sediments.

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Taxonomy of Green Bacteria

In the past, various small organisms have been described as 'Green Bacteria', but for the most part too inaccurately to be sure of their identity. In 1906, however, Nadson[1] (cf. also ref. 2) gave the name *Chlorobium limicola* to a microaerophilic, chlorophyll-containing organism of bacterial dimensions which shares the habitats of Purple Bacteria, and which has been studied in pure culture by van Niel[3]. Lauterborn[4] proposed the family Chlorobacteriaceæ for a group of similar organisms which, when in a mass, appear yellow-green.

Morphological studies caused Geitler and Pascher[5] to include in the Cyanochloridinæ = Chlorobacteriaceæ a considerable number of species which they described in an appendix to the Cyanophyceæ (cf. also ref. 6). Among these there are yellow-green as well as blue-green forms. Since some Cyanophyceæ are always yellowish, and many others, under unfavourable conditions, fade to a similar hue, it is impossible to decide without culture experiments where these bacteroid forms belong.

In such experiments a number of these forms, isolated from mud, proved to be blue-green, to contain chlorophyll *a* (no *b*), and to produce oxygen bubbles when exposed to strong illumination. Such organisms are evidently true, though very small, Cyanophyceæ, whereas others, growing only after the oxygen has been consumed by other bacteria, are greenish-yellow viewed against the light, but dark bluish-green in incident light. They contain a green pigment, identical with the bacteriochlorophyll of Purple Bacteria. This was confirmed with the help of a pure culture of *Chlorobium thiosolfatophilum*, made by Dr. H. Larsen in van Niel's laboratory at the Johns Hopkins Marine Station, and kindly sent to us.

Other pigments previously isolated from similar organisms were products of decomposition. Comparison of the absorption spectra of the living cells with those of their pigments in solution and isolated by sugar chromatography prevents this error.

Our result shows that the relation of the "Green Sulfur Bacteria", as they are called by van Niel, to the Purple and Brown Bacteria, is still nearer

than he believed. I propose to call all these together 'Chlorobacteriales' because they have the bacteriochlorophyll in common.

The pigment analyses were carried out in the Botany Department of the University of Heidelberg under the supervision of Prof. A. Seybold, to whom I am grateful for his collaboration.

E. G. Pringsheim

Strangeways Laboratory,
Cambridge.
May 23.

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Deposition of a Coarse Aerosol released from a Low-flying Aircraft

Experiments are being carried out in East Africa to investigate the behaviour of coarse aerosols released from low-flying aircraft. Such aerosols, the droplets of which have diameters covering approximately the range 5–200 microns, are much used in an *ad hoc* fashion to control insect pests; but little is known of the effect upon their behaviour of variations in meteorological and other field conditions.

Aerosol behaviour is complex under field conditions, and the number of variables must be limited if ordered knowledge is to be obtained. It is difficult enough to treat mathematically gaseous diffusion in the atmosphere when the source is relatively non-turbulent; when the problem is complicated by sedimentation effects and the presence of a very turbulent source such as an aircraft's slipstream, and also by variations in surface vegetation and ground contour, any investigation must of necessity be mainly empirical.

As a preliminary basis to our work, we have investigated in open country the form of the ground deposit of an aerosol released from a low-flying aircraft flying across the wind. We have used a constant aircraft height of 30 ft., a constant drop spectrum, and only one solution. The aerosol was produced from a boom-and-nozzle apparatus fitted to an Anson aircraft, had droplets varying from 5 microns to 250 microns approximately, and had a mass median diameter of 70–80 microns. The solution was a 10 per cent w/v solution of technical DDT (80 per cent *pp'* isomer of DDT) in a solvent consisting of 1 part of Shell 'Power Kerosene' to 1 part of Shell 'Diesoline'.

The degree of atmospheric turbulence was measured by a parameter deduced by Deacon (unpublished) as an effective and measurable replacement for the Richardson's number. We have used it in the form:

$$F = \left\{ \frac{T_{10} - T_{2\cdot5} + \Gamma.\delta h}{(u_5)^2} \right\},$$

where T_{10}, $T_{2\cdot5}$ are the air temperatures (in deg. F.) at heights of 10 m. and 2·5 m., respectively. u_5 is the mean wind speed (in ft. per sec.) at a height of 5 m., and $\Gamma.\delta h$ is the numerical value of the dry adiabatic lapse over an interval of 7·5 m. Thus F is positive for inversions, zero for dry abiabatic lapse-rates, and negative for super-adiabatic lapse-rates.

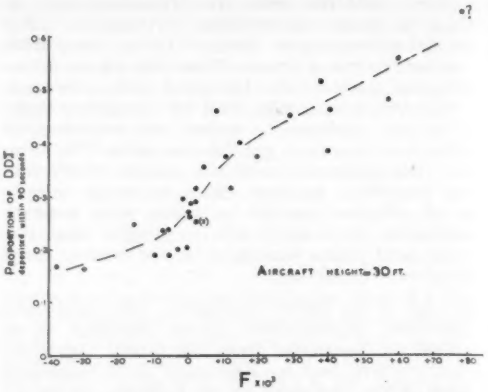

Fig. 1. Proportion of DDT deposited within an interval of 90 sec., for various values of F, the measure of the degree of atmospheric turbulence

Ground deposits were measured in two ways: by size-counts upon glass plates coated with magnesium oxide, and by colorimetric estimations of a fast dye added to the solution. Actual volumes of deposits were obtained from the size-counts, whereas the colorimetric method gave equivalent dosages of DDT, or of volume of original solution. Some measure of losses of solvent by evaporation was therefore possible.

The deposit of DDT, expressed as a proportion of the amount emitted from the aircraft, was summed for various values of the ratio (distance downwind)/(mean wind speed at 5 m.). This ratio gives an approximate measure of the time-interval elapsing between production of the droplets and their deposition at a sampling point. The variation of this proportion with changes in F, the measure of atmospheric turbulence, is shown in Fig. 1; a time interval of 90 sec. has been considered. It is evident that the aerosol is deposited more readily during inversions than during conditions of super-adiabatic lapse-rate.

The various experiments were grouped according to their values of F, and for each group the average values of the proportion deposited were calculated

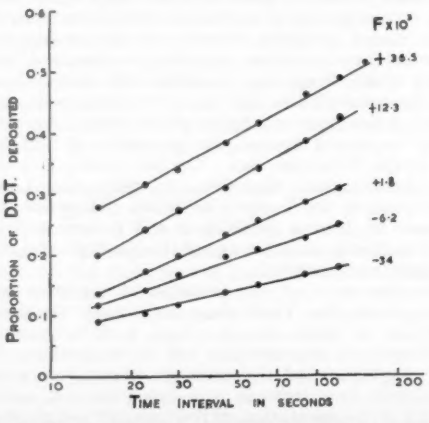

Fig. 2. Variation with time-interval of the proportion of DDT deposited upon the ground, for different degrees of atmospheric turbulence

for various time-intervals. The results are shown in Fig. 2, where time-intervals are recorded on a logarithmic scale. The graphs show that the total deposit increases most rapidly with time during inversions.

Comparison of results from the two methods of assessment showed that deposits collected beneath the aircraft track had solution strengths which were approximately double that of the original solution, that is, 50 per cent of the solvent had been lost during the very few seconds required for these deposits to form. A correlation test showed that the loss of solvent increased significantly with time-interval, but so slowly that after 3–4 min. the losses had only increased to 60 per cent. It seems probable that the kerosene evaporates very rapidly during the first few seconds after the droplets have been formed, leaving droplets composed of relatively involatile substances.

The results suggest that a simple, practicable relationship can be found between aerosol behaviour and simple meteorological measurements. The exact form of the behaviour of an aerosol will depend greatly upon the sizes of its constituent droplets, and our results are being analysed to discover how droplets of various sizes are deposited. A preliminary study suggests that the smaller the droplet the greater is the effect of a change in the degree of atmospheric turbulence, as would be expected. Experiments are also being carried out with different heights of the aircraft, and over areas of woodland.

A fuller account of this work is to be published elsewhere.

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Dec. 30.

Longitudinal Elastic Waves in Cylindrical Rods

Although Pochhammer's[1] well-known solution for elastic waves in cylindrical rods has been in existence for many years, two problems arising out of it in connexion with longitudinal motion have yet to be solved.

The first difficulty relates to the physical significance of the higher modes (as opposed to their theoretical importance, which has been explained by Cooper[2]). The transmission of a pulse in one of the higher modes would be evidenced by very high phase velocities for long waves and, in the course of carefully planned experiments with a pressure bar, Davies[3] did not detect such an effect (see, however, Morse[4], who describes experiments with rectangular rods). An explanation of this fact would be reassuring, since engineering theories of longitudinal waves do not give rise to higher modes[5].

The second problem is that pointed out by Love[6], and concerns a free end of the cylinder where reflexion occurs. The stresses of Pochhammer's solution may be written in the form:

$$\mathbf{xx} = (\text{real function of } r)\ \exp\{i\,\xi\,(x - ct)\} \qquad (1)$$
$$\mathbf{xr} = (\text{imaginary function of } r)\ \exp\{i\,\xi\,(x - ct)\}$$

for any particular wave number ξ and phase propagation speed c. Thus, if the normal stress **xx** is always to vanish at a free end, **xr** will not do so.

This problem may be regarded as if perfect reflexion occurs with the superimposed effects of an *applied* stress system:

$$\mathbf{xx} = 0\ ;\ \mathbf{xr} = (\text{function of } r)\ \exp(i\,\xi\,ct) \qquad (2)$$

at the hitherto free end. Now the question arises: Is the effect of the auxiliary system (2) local, or does it, in some way, distort the retreating reflected wave? It is, perhaps, to be expected that the effect is local since steady longitudinal vibrations of a rod might not otherwise be possible; but it would be virtually impossible to find the answer by direct experiment.

Pochhammer's results are reached if the trial solution:

$$u_x = f_1(r)\exp\{i\,\xi\,(x-ct)\}\ ;\ u_r = f_2(r)\exp\{i\,\xi\,(x-ct)\};$$
$$u_\theta = 0 \qquad (3)$$

is used in the general equations of motion. If equations (3) embrace the most general longitudinal wave and they inevitably lead to equations (1), it is apparent that a motion giving (2) is not possible. This is obviously so if, in fact, the only physically realized mode of Pochhammer's solution is the first.

What is the alternative if displacements due to system (2) are not propagated? Since the applied force always has zero resultant, the problem is analogous to those involving an appeal to St. Venant's principle, the disturbance now being time-dependent. It has been shown by Goodier[7] that the effects would be local in the static case as a simple consequence of the conservation of energy. In the absence of wave transmission, this would still be true for dynamical cases. Thus a harmonic wave approaching a free end would suffer complete reflexion. But its form would become temporarily blurred near the stress-free section.

These views are advanced as a suggestion rather than as a proof. They are offered because it appears to me that this is not the only vibration problem the exact solution of which could be completed by the establishment of some form of dynamical St. Venant principle; for example, certain plate problems seem to fall into this category.

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Feb. 27.

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Elastic Deformation and the Laws of Friction

It has been shown by Bowden and his co-workers[1] that the classical law of friction $F = \mu W$ is dependent on plastic deformation of the asperities in contact on the rubbing surfaces. In the case of high polymers, however, Lincoln[2] has shown that, ideally, relationships of the form $F = kW^{2/3}$ are to be expected at small loads, as a result of elastic deformation of the asperities. Other examples of high polymer friction[3], and particularly the friction of textile fibres[4,5], indicate similar relationships although, in the case

Relation between Frictional Force and Load in Textile Fibres

Material	Value of index n in $F = kW^n$	Reported by
Fibro rayon	0·75–1·0	Guthrie and Oliver (ref. 4)
Cellulose acetate	0·96	Howell (ref. 5)
Viscose rayon	0·91	
Undrawn nylon	0·90	
Drawn nylon	0·80	

of textile fibres, of a more general form $F = kW^n$, where n may lie between 0·67 and unity (see table).

It is commonly supposed that if a law of the type $F = kW^n$ is obtained, then as the value of n approaches unity so also the deformation of the asperities must approach more closely a state of full plasticity, so that when $n = 1$ the deformation is entirely plastic and Amontons's laws are valid. The assumption that $n > 0{\cdot}67$ indicates that some degree of plastic deformation may, however, be unjustified, and may lead to an inaccurate concept of the deformation process actually occurring. In general, if N asperities are involved in the frictional process, the frictional relationship would be of the form $F = \sum_1^N C_i W_i^{2/3}$, which does not imply $F = kW^{2/3}$ except in special circumstances. For example, if contact between two cylindrical fibres, possessing longitudinal fluted asperities of uniform cylindrical cross-section and being uniformly distributed, is considered, it is possible, using Hertz's classical formulæ[6], to show that the relationship between frictional force F and load W is:

$$F = SW^{8/9} R_c^{2/9} R_a^{2/3} K/d^{2/3}, \qquad (1)$$

where S is the effective shear strength at the interface in the real area of contact, R_c the radius of the fibres, R_a that of the asperities and d their distance apart, and K a constant which includes the Young's modulus of the materials to the power $-8/9$. A similar relationship is obtained for the friction between a hemispherical specimen (with spherical asperities) and an ideally plane surface. Thus, although the deformation of the asperities was postulated initially as being completely elastic and conforming to the Hertzian power law, the gross frictional force F is proportional to $W^{8/9}$, a result which, if obtained experimentally, might be assumed to indicate that the deformation of the asperities is partly plastic. Equation (1) also illustrates the dependence of the frictional properties on the surface configuration of the rubbing elements—another non-classical feature of the friction of high polymers which has been discussed by me elsewhere[2]. It is only possible, therefore, to decide between plastic and elastic deformation of surface asperities when their dimensions and distribution are known.

A full account of this theoretical treatment will be published elsewhere in due course.

B. Lincoln

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Leeds 6.
March 6.

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Cleavage Fracture of Zinc Single Crystals

Fracture by cleavage across the crystals of a polycrystalline metal is typical of many examples of brittle fracture. The cleavage plane is crystallographic and is observed always to be one of a very limited number of planes irrespective of the orientation of the crystal with respect to the applied stress. In zinc it is likely that the cleavage plane is always (0001), although the crystal may twin before it fractures[1].

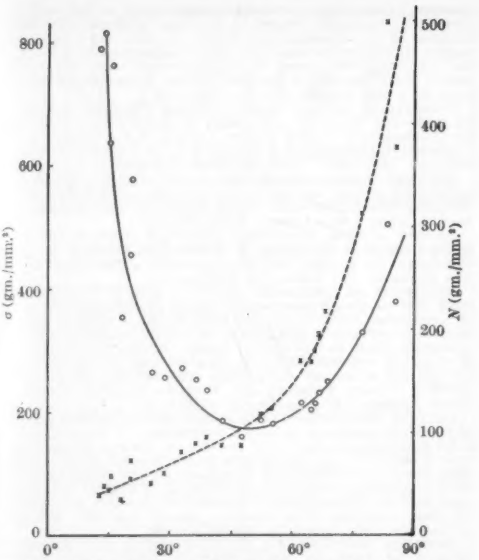
The stress conditions necessary to cause cleavage fracture are not well established, although it has generally been assumed that fracture occurs when the resolved component of the applied stress perpendicular to the most favourably orientated cleavage plane exceeds a critical value. This is known as Schmcke's law, and was formulated following experiments on the fracture of single crystals of sodium chloride. Later work, largely by Schmid and his co-workers, led to the belief that the law was also obeyed for cleavage fractures in bismuth, tellurium, zinc and antimony. This work, and also other work on ionic crystals, has been summarized by Schmid and Boas[2]. Since 1930, little attention has been given to the problem.

Closer examination of the results of Schmid *et al.* raises some doubt as to the general validity of the normal stress law. While some of the results, notably those for bismuth, confirm the law very well, others are not in such good agreement. For zinc, Schmid[2] only obtained results for crystals for which the angle χ between the direction of applied tensile stress and the cleavage plane lay in the range 12–50°; even here the agreement was not very good. Therefore, before proceeding with an investigation of the factors influencing the cleavage strength of zinc single crystals, we felt it advisable to determine whether the stress normal to the cleavage plane was the criterion for fracture.

The zinc used was of 99·99 per cent purity, the main impurities being lead 0·002 per cent, cadmium 0·0015 per cent, copper 0·001 per cent and iron 0·0015 per cent. Single crystals, 6 mm. diameter and 18 cm. long, were grown in argon using the Andrade and Roscoe technique. The moulds employed were of precision-bore glass tubing coated internally with graphite. It was possible to remove the crystals from the moulds without straining them, and care was taken throughout other handling operations to avoid any accidental strains. The crystals were then broken in liquid nitrogen (− 196° C.) using a tensile testing machine in which the stress was applied as near axially as possible. The crystals deformed plastically before fracture, and all results have been referred to the final dimensions and orientations of the crystals.

The graph shows the applied tensile stress, σ, and the resolved component of the stress perpendicular to the cleavage plane, N, at fracture, in each case plotted against χ. Results for crystals for which $\chi < 12°$ have not been plotted, since these did not fracture across the basal plane of the original crystal. It is clear that the stress normal to the cleavage plane is far from constant at fracture.

It seems most unlikely that any non-axial loading would cause such a regular variation of N with χ. However, it is possible that N is affected by the plastic deformation before fracture, which increased from about 1 per cent glide strain when χ approached 90° to about 40 per cent when χ was as low as 15°. An initial very rapid fall of N with glide strain



—○—, Tensile stress parallel to axis of crystal at fracture; – – × – –, tensile stress normal to cleavage plane at fracture

followed by a slower rate of decrease would explain our results if a critical normal stress law applied to completely brittle fractures. It is not easy to test this hypothesis in the important range of plastic strain between 0 and 5 per cent, but our results show that varying the glide strain between 10 and 140 per cent at room temperature, before fracture at − 196° C., does not decrease N. It must not be forgotten, however, that Schmid's work, on which the normal stress law is partly based, was on crystals which deformed before fracture, and from this point of view the results are directly comparable.

Although no success has yet been obtained in finding an alternative criterion for cleavage fracture, these results make it clear that it is not always one of a critical stress normal to the cleavage plane.

A. E. Debuyttere
G. B. Greenough

Department of Metallurgy,
University, Sheffield.
Feb. 2.

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[3] Schmid, E., Proc. Internat. Congr. App. Mechanics, Delft, 342 (1924).

Structure of Selenium Tetrafluoride

Selenium tetrafluoride was first described in 1907 [1], but the compound does not seem to have been obtained pure until quite recently [2]. It is not a particularly easy substance to handle, since it rapidly attacks tap-grease and also reacts slowly with 'Pyrex' glass, forming crystalline selenium dioxide and gaseous silicon tetrafluoride with a trace of boron trifluoride. It is also hydrolysed instantaneously by water or moist air to the dioxide.

I have been studying the structure of this compound by the method of electron diffraction. The first set of diffraction photographs taken showed a pattern closely resembling that described for silicon tetrafluoride and was therefore rejected. A second sample was treated in the following manner. The sample holder was allowed to stand in contact with selenium tetrafluoride vapour overnight and then pumped out before the sample was distilled into it. The freshly distilled material was allowed to stream into the electron diffraction camera for some time before photographs were taken, so that any silicon tetrafluoride present should have been pumped off.

The second set of photographs gave a consistently different pattern from the first set, and this pattern was considered to be caused by substantially pure selenium tetrafluoride. Six maxima were observed extending to $s = 23$ A.$^{-1}$. A radial distribution curve gave a large peak at 1·76 A. and a much smaller, unsymmetrical peak at about 3·0 A. The first peak presumably corresponds to the Se—F distance (about 1·7 A. in SeF_6), which contributes 72 per cent of the total scattering, and the second to the F...F distance or distances, which contribute the remaining 28 per cent of the scattering. If the fluorine atoms were arranged in a regular tetrahedron with Se—F 1·76 A., the second peak should be at 2·87 A.

Scattered intensity curves were calculated for ten models in the usual way. In eight of these models, all four Se—F distances were assumed to be equal and the fluorine atoms were arranged in various possible ways, including a square, a regular tetrahedron and a variety of distorted tetrahedra. Two further models were tried in which two of the Se—F distances were assumed to be longer than the other two. Only one model was found to give completely satisfactory agreement with the visually estimated ring intensities. This model has a distorted tetrahedron of fluorine atoms around the selenium atom with two opposite FSeF angles of 120° and the remaining four FSeF angles equal to 104·5°. The scaled Se—F distance from this model is 1·765 ± 0·025 A., and the uncertainty in the angles ± 10°.

The best model has C_{2v} symmetry, which is consistent with some unpublished results obtained by J. A. Rolfe and L. A. Woodward from the Raman spectrum of the liquid. Only two other Group VI tetrahalides have been studied previously by electron diffraction. In the case of selenium tetrachloride[3] the structure was not determined, and in any event the compound was probably decomposed into a lower chloride and chlorine in the vapour state[4]. The structure of tellurium tetrachloride was found by Stevenson and Schomaker[5] to be a distorted tetrahedron with the majority of the ClTeCl angles equal to 93° ± 3°.

I am indebted to Dr. P. L. Robinson for supplying samples of selenium tetrafluoride, to Mr. J. A. Rolfe for distilling these, to Dr. L. A. Woodward for helpful discussions and to the Department of Scientific and Industrial Research for a maintenance grant.

H. J. M. Bowen

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South Parks Road,
Oxford.
March 20.

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FORTHCOMING EVENTS

Sunday, July 26—Friday, July 31

SECOND INTERNATIONAL CONGRESS ON RHEOLOGY (in the Music Room, Holywell Street, Oxford).

Monday, July 27

At 11 a.m.—Sir Geoffrey Taylor, F.R.S.: "Rheology for Mathematicians" (Presidential Address).

Tuesday, July 28

NUTRITION SOCIETY (at the National Institute for Research in Dairying, Shinfield, Reading), at 11.15 a.m.—Scientific Papers and Demonstrations.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

UNIVERSITY LECTURER or UNIVERSITY DEMONSTRATOR IN THE FACULTY OF ENGINEERING, to teach primarily in thermodynamics and mechanical engineering—The Appointments Committee, Engineering Laboratory, University of Cambridge, Cambridge (July 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF ECONOMIC SCIENCE—The Registrar, The University, Liverpool (August 1).

CHEMIST, male (with first- or second-class honours degree in chemistry), IN THE FUELS AND LUBRICANTS SECTION, Central Laboratory, Chiswick—The Staff Officer (F/EV.241), London Transport, 55 Broadway, London, S.W.1 (August 1).

DEPUTY SENIOR CHEMIST (with honours degree or equivalent, and at least five years experience in the gas or chemical industries) for analytical and investigational work, and the supervision of such work—Industrial Relations Officer, West Midlands Gas Board, 6 Augustus Road, Edgbaston, Birmingham 15 (August 1).

LECTURER IN AGRICULTURAL CHEMISTRY and a LECTURER IN AGRICULTURAL BIOLOGY (with agricultural degree, or equivalent degree in the appropriate science)—The Secretary, Shuttleworth College, Old Warden Park, Biggleswade, Beds (August 1).

PLANT PHYSIOLOGIST (with sound fundamental training, together with research experience) for studies on the physiology and metabolism of fruit under storage conditions in relation to orchard factors—The Secretary, East Malling Research Station, Maidstone, Kent (August 1).

RESEARCH ASSISTANT (with honours degree in chemistry)—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (August 1).

ASSISTANT LECTURER IN MATHEMATICS (Pure or Applied)—The Principal, Royal Holloway College, Englefield Green, Surrey (August 6).

ASSISTANT PHYSICIST (with good honours degree in physics) at the Hogarth Radiotherapeutic Centre—The Secretary, Nottingham General Hospital, Nottingham (August 8).

LECTURER (with first- or second-class honours degree in mechanical engineering, and preferably with knowledge of one or more of the following subjects: (*a*) materials and structures, (*b*) fluid mechanisms, including supersonics, (*c*) ballistics, (*d*) servomechanisms) IN THE DEPARTMENT OF APPLIED MECHANICS—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (August 8).

LECTURER IN MATHEMATICAL PHYSICS—The Secretary, The University, Edinburgh (August 8).

ASSISTANT STATISTICIAN (Assistant Experimental Officer grade) (with pass degree or equivalent qualification, and preferably with knowledge of both mathematics and horticulture, or botany) for the examination and analysis of experimental data—The Secretary, East Malling Research Station, Maidstone, Kent (August 14).

EXPERIMENTAL OFFICER (H.N.C. or better in physics, and preferably with research experience, including electronics experience) IN THE D.S.I.R., Food Investigation Torry Research Station, Aberdeen, to work on general physical problems relating to fish—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.116/52/A (August 14).

ASSISTANT LECTURER IN BOTANY (with special reference to either cytology, genetics or ecology)—The Registrar, The University, Nottingham (August 15).

ASSISTANT LECTURER IN GEOGRAPHY at Makerere College, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 15).

LECTURER (qualified either in Science (physical or biological) or Mathematics, and with teaching experience) IN THE DEPARTMENT OF EDUCATION—The Registrar, University College of Wales, Aberystwyth (August 15).

LECTURER IN PHYSIOLOGY—The Registrar, King's College, Strand, London, W.C.2 (August 15).

ELECTRONIC ENGINEERS OR PHYSICISTS, Principal Scientific Officer grade (with first- or second-class honours degree, or corporate members of the Institution of Civil or Mechanical or Electrical Engineers, or with evidence of outstanding ability) in the Royal Naval Scientific Service, Gloucestershire, to take charge of teams responsible for design of large-scale equipment and its development to prototype stage—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4226/53 (August 20).

CHEMICAL ENGINEER (Principal Scientific Officer or Senior Scientific Officer) (with first- or second-class honours degree, or good post-graduate diploma in chemical engineering) at the Atomic Weapons Research Establishment, Aldermaston, to lead team engaged in chemical engineering research, and development of plant and equipment concerned with radioactive materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.335/53A (August 22).

SCIENTIST (Grade II), a SCIENTIST (Grade III) or SCIENTIFIC TECHNICAL OFFICER (Grade I) (with degrees or equivalent in physics, chemistry, mathematics, or mining engineering) on the staff of the Director of Scientific Control in the East Midlands (Nottingham) Division of the National Coal Board, to carry out environmental studies at collieries in connexion with a long-term field research into the occurrence and causes of pneumoconiosis—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/655 (August 24).

LECTURER IN ZOOLOGY at the Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

ASSISTANT LECTURER IN PHYSIOLOGY in the School of Pharmacy—The Secretary, Royal Technical College, Glasgow.

ASSISTANT METEOROLOGIST (with H.S.C. or equivalent in mathematics and physics, and forecasting experience or training) with the Mauritius Government—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M3B/33530/TA.

BRITISH RUBBER PRODUCERS' RESEARCH FELLOW (with good honours degree in engineering or physics, and industrial or research experience) for research into the mechanical properties of rubber—The Registrar, The University, Nottingham.

ELECTRICAL OR MECHANICAL ENGINEER (Senior Scientific Officer) (with first- or second-class honours degree or equivalent in electrical or mechanical engineering, and at least three years postgraduate research experience) in the Ministry of Supply Design Establishment, Sevenoaks, Kent, to lead section engaged in design and development of electrical and mechanical components and of complete control schemes for armament equipments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.285/53A.

PHYSICAL METALLURGIST (with postgraduate experience and preferably with knowledge of industrial techniques); a PHYSICAL CHEMIST (with postgraduate experience) to carry on research in some applied field of chemistry and to supervise junior research staff; a CHEMIST (with postgraduate experience in textiles) for short-term development work in physical testing, and an HONOURS CHEMISTRY GRADUATE to carry out the investigation of biochemical problems associated with the food industries—The Director, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Ontario, Canada.

RESEARCH ASSISTANT FOR MICROBIOLOGICAL AND BIOCHEMICAL ASPECTS OF WORK ON MEGALOBLASTIC ANÆMIAS—The Registrar, King's College, Newcastle-upon-Tyne.

RESEARCH FELLOW, Junior or Senior (graduate with biophysical or physiological experience and interest in cerebral dynamics) IN THE DEPARTMENT OF MENTAL HEALTH—Prof. Millar, The University, Aberdeen.

RESEARCH FELLOW or RESEARCH STUDENT (preferably with knowledge of electronics) IN THE DEPARTMENT OF PHYSICS, for fundamental investigations of either semiconductors or ferromagnetic materials—The Registrar, The University, Nottingham.

RESEARCH FELLOW IN SCIENCE—The Secretary, The University of Durham, 38 North Bailey, Durham.

SCIENTIFIC OFFICERS (with first- or second-class honours degree or equivalent in physics, mathematics or engineering) for operational research on wide variety of problems, under the direction of the Scientific Adviser to the Air Ministry, in London and the provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.285/52A.

WOOL TEXTILE RESEARCH COUNCIL SCHOLARSHIP IN ORGANIC CHEMISTRY—The Principal, Technical College, Bradford.

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